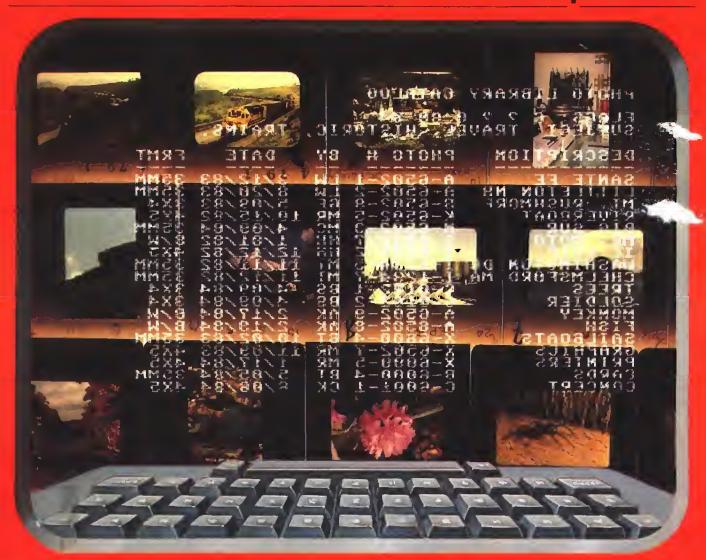
for the Serious Computerist



Plotting Binary Trees



g for C64 r Apple e

68000 p-System BASIC FORTH Interactive Input Utility



the Computer Olympics here.

The 1541 FLASH! loaded and saved programs and files three times faster than an unenhanced Commodore

...faster than any other disk disk drive with comdrive..."

1541 disk drive could. Faster than any other patible disk format. Three times faster!

The device delighted the home crowd, which watched the 1541 FLASH! set a meet record, and leave its competition in the dust.

Once installed, the 1541 FLASH! is transparent. Computer operations all remain unaffected as it speeds up every disk-related function. The FLASH! is a permanent installation with both a software (ROM) and a hardware component. Through keyboard commands or a hardware switch, you can even return to the old, slow loading method-if you really want to.

And there is nothing new to learn for the FLASH! No special tricks or

But if you're really serious about programming, the 1541 FLASH! is a gold mine. The manual will show you how to write software allowing data transfer to and from the 1541 disk drive at speeds up to 10 times the normal.

For programs that usually load with a " '*',8,1" command, just hit Shift/Run-Stop. A spreadsheet program like BUSICALC 3 then loads in about 25 seconds.

The 1541 FLASH! even adds 21 extra commands for the Commodore 64 user. Some of these include editing, programming and loading commands, as well as "DOS Wedge" commands. You can ignore all these commands, though, and just enjoy the rapid disk operations.

It wowed the crowd at the Computer Olympics. Once you see its sheer speed, you'll know why. Call its coach, Skyles Electric Works, to place your order or to get more info.

1541 FLASH!. an add-on assembly, for the Commodore 64/1541 costs only \$89.95.



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DIGITAL DEVICES 5

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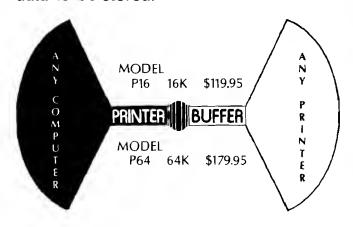


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MicroMotion

MasterFORTH

It's here — the next generation of MicroMotion Forth.

- Meets all provisions, extensions and experimental proposals of the FORTH-83 International Standard.
- Uses the host operating system file structure (APPLE DOS 3.3 & CP/M 2.x).
- Built-in micro-assembler with numeric local labels.
- A full screen editor is provided which includes 16 x 64 format, can push & pop more than one line, user definable controls, upper/lower case keyboard entry, A COPY utility moves screens within & between lines, line stack, redefinable control keys, and search & replace commands
- Includes all file primitives described in Kernigan and Plauger's Software Tools.
- The input and output streams are fully redirectable.
- The editor, assembler and screen copy utilities are provided as relocatable object modules. They are brought into the dictionary on demand and may be released with a single command.
- Many key nucleus commands are vectored. Error handling, number parsing, keyboard translation and so on can be redefined as needed by user programs. They are automatically returned to their previous definitions when the program is forgotten.
- The string-handling package is the finest and most complete available.
- A listing of the nucleus is provided as part of the documentation.
- The language implementation exactly matches the one described in <u>FORTH TOOLS</u>, by Anderson & Tracy. This 200 page tutorial and reference manual is included with MasterFORTH.
- Floating Point & HIRES options available.
- Available for APPLE iI/II+/IIe & CP/M 2.x users.
- MasterFORTH \$100.00. FP & HIRES –\$40.00 each
- Publications
 - FORTH TOOLS \$20.00
 - 83 International Standard \$15.00
 - FORTH-83 Source Listing 6502, 8080, 8086 \$20,00 each.



highlights

Fast Bit Map Plotting. This is the first in a multi-part series that will discuss the theory of plotting hi-resolution points, lines and other picture elements in the Commodore 64 — and provide a collection of assembly level subroutines to perform these functions. The subroutines, which may be called from BASIC, provide a very fast and efficient method of 'unlocking' the hiresolution capabilities of the C64. The second article in the series will add the routines necessary to draw lines between points. These will allow the C64 programmer to generate USR calls that are equivalent to the Applesoft HPLOT routines, and will let the C64 user convert programs written for the Apple, such as 'Plotting Binary Trees' in this issue, to the C64.

Plotting Binary Trees — Binary trees are a form of mathematical graph that display interesting properties. The short program provided calculates all of the information required to plot these binary trees on a microcomputer display. The user may specify the parameters that govern the 'growth' of the tree and observe the results in a very graphic fashion. While the plotting portion of the program is specific to Applesoft, relying on the HPLOT function, it should be convertable to almost any other micro.

Database Management Systems. Approximately 42% of the MICRO readers reported that they use their systems for database management. This article explores the significant features of database managers (DBMs) and can be used as a guide to selecting the appropriate package for your applications on your computer. Part 1 of the two part article looks at the DBM features in general and is applicable to all microcomputers. Part 2, scheduled to appear in next month's issue, applies the concepts developed in Part 1 to evaluate a large number of the DBMs available for the Commodore 64.

BASIC/ML Data Transfer. Many computer problems are best solved by combining the ease of BASIC with the speed of machine language programming. Unfortunately, BASIC is not as supportive of ML data as it might be. Sure, you can PEEK and POKE all day, but then you are apt to lose all of the efficiency and speed you set out to achieve. Four techniques are presented to permit BASIC and ML data to work together.

A Very Moving Message. Sometimes an effect that looks simple can actually be the result of very complex operations. This article includes a program that allows a message to be scrolled across the screen of the Commodore 64 while other activities are going on. Simple? Not really. As the article shows, it requires a use of interrupts, split-screen capability and smooth scrolling to make it work. Each of these concepts is explained and the resulting demonstration program makes them clear. The 'Moving Message' routines can be added to your own programs to make them look attractive, professional and make them easier to use.

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Contributing Editors

Cornelis Bongers
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David Malmberg
John Steiner
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MCRO

for the Serious Computerist

OCTOBER

1984

Plotting Binary Trees

Luther K. Branting

Binary Trees are an interesting form of mathematical graph. Here is a program to generate and display them.

Fast Bit Map Plotting for the Commodore 64

Loren W. Wright

Part 1 of a series of assembly level routines to support fast hiresolution bit map plotting on the Commodore 64.

Machine Language
Loops

Chris Williams

Machine language loops are explored — and some common misconceptions about them exposed.

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Mike Dougherty

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Sanjiva K. Nath

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BASIC/ML Data
Transfer

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Four techniques are explored and implemented to exchange data between BASIC and machine level programs.

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A Very Moving Message

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Split screen, fine scrolling and interrupt techinques are combined in a useful utility for the Commodore 64.

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Interface Clinic A Mystery!

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Quick Cipher Routine

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editorial

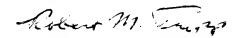
Autumn is my season for reflection.

Is it possible that MICRO started publication seven years ago and is now starting its eighth year? Have we changed much since that first issue in October 1977? Have we accomplished our original goals? Wondering, I went back to the first issue and reread my editorial. I think that you might enjoy reading it too, in its original published form.

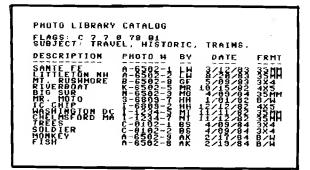
Is the 6502 still number one? With the popularity of the Apple II, Commodore 64, VIC-20, Atari and other 6502-based systems, there is probably no argument now, but that was not the case back then. Although newer chips are making their mark, the 6502 continues to be the leader.

Have we attracted "individuals who are industrious, able, cooperative, adventurous and communicative" as readers? Examine the results of the June 1984 survey and judge for yourself.

If MICRO is the "most useful journal" for you, then "We're Still Number One!"



On The Cover



When someone mentions 'Data Base Management', most of us probably think in terms of business computer-oriented materials — mailing lists, inventory control and so forth. DBM's can be used for many personal uses as well. The cover shows a collection of photographic slides that can be encoded and selected via a DBM. Other personal examples could include large record and tape collections, hobby classification systems and more.

We're Number One !

An Editorial

We're number one in microcomputer systems. With over twelve thousand KIM-1 microcomputers in the filed and a thousand per month being ordered, plus a good number of Apple I and Apple II systems, plus a variety of OSI units, Plus the Jolts, Data Handlers, and other 6502-based systems, plus the huge numbers of PETs and Microminds that have been ordered, plus a lot of home-brew 6502 systems - it all adds up to a tremendous number of 6502-based microcomputer systems in use throughout the world. Adding to this number are the one and one-half million 650x chips purchased by Atari for some of their games. We've come a long way in the past year.

We're number one in microprocessor power. Microchess for the KIM-1 took 1.1K and for the 9080A took about 2.5K. Of thirty-one BASICs tested and reported in Kilobaud, the four 6502 versions placed in the top five spots, yielding only second place to the Z-80 running at 4 MHz. The 6502's many addressing modes make it very efficient and easy to program.

We're number one in user participation. Maybe there is some process of "natural selection" which attracts individuals who are industrious, able, cooperative, adventurous and communicative to the 6502. While users of other microprocessor chips have been "spoonfed" via company supported user notes and user libraries, the 6502 users have been "doing their own thing" as evidenced by the activity level of many local 6502 groups and the success of the KIM-1/6502 User Notes.

We're number one since this is our first issue. We would like to really become the most useful journal in the whole microcomputer field, not the largest, just the best. We are undertaking the venture with the conviction that there is a need for a journal to help bring all of the separate parts of the 6502 world together and with the belief that 6502 users will each do what they can to support the effort.

Plotting Binary Trees

by Luther K. Branting Denver, Colorado

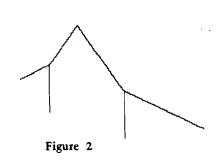
A Program to Plot an Interesting Class of Graphs: Binary Trees

Trees are a form of graph that play a special role in computer science. Most artificial intelligence is based upon tree-like decision paths and trees are used to model such diverse natural phenomena as river basins, languages and plant growth. Graphs of trees also form an endless variety of fascinating and beautiful patterns.

A tree is a graph consisting of a vertex called a root and one or more line segments branching from the root. Additional branchings may occur from the end points of each branch. A binary tree is a special form of tree in which the root has exactly two branches and each of the branches, in turn, has exactly two more branches. With each additional branching, or generation, the number of end points doubles.

Figure 1 shows a two-generation binary tree. A and B are the first generation branches. C, D, E and F are second-generation branches. In this tree, each left branch is inclined at an identical angle, LA, from the previous branch. Similarly, RA is the angle of each right branch. All the branches are the same length.

Figure 2 shows the same tree except that now each left branch is only .6 times as long as the previous branch.



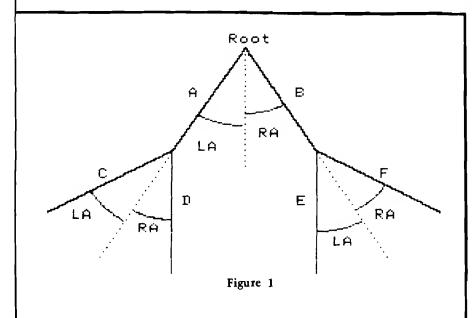
The ratio of each branch to the previous branch is called the growth factor of the branch. In general, each tree of this type can be specified by giving the left and right branch angles, the left and right growth factors, the length of the first two branches and the number of times the branching is to occur.

The program listed below prompts the user for the number of generations of the tree, left and right branch angles and growth factors and the scale, a number which is multiplied by the left and right growth factors to obtain the lengths of the initial left and right branches. After the tree is drawn, pressing any key will clear the screen and present the user with the options of plotting a new tree, sending the tree just plotted out to a printer, or quitting.

As each new generation is drawn, the arrays X1[i] and Y1[i] hold the X and Y coordinates of the end point of the ith branch of the existing tree. A[i] holds the angle of the ith branch and L[i] holds its length. Similarly, X2, Y2, A2 and L2 contain the coordinates, angle and length of each new branch being drawn. After each generation is drawn, the values in X2, Y2, A2 and L2 are transferred to X1, Y1, A1 and L1 so that the end points of the current branches can be used as the starting points of the new generation of branches.

When starting out, it is best to use growth factors between 1 and 0.5. Angles that are the result of dividing 360 by an integer, like 30, 45, 60 and 72 degrees, seem to produce the most attractive trees. There seems to be an affinity between angles that are a multiple of 30 degrees and the growth factors .618 and 1, and between angles that are a multiple of 45 degrees and the growth factors .707 and 1. In the interest of speed and simplicity, the program does not proportion the tree being drawn so that it fits within the screen. It is up to the user to select an appropriate scale. If the tree is microscopic, try a larger scale. If the tree falls outside of the screen, the program prompts for a smaller scale.

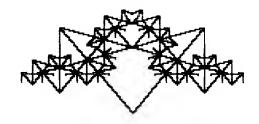
By plotting a series of trees that vary in their angles and growth factors only slightly, one can create the illusion of flowers opening or crystals growing. Some examples of trees are shown below. Note that in Figure 3, the end points of the tree are converging on a



fractal curve similar to the Koch curve described in Plotting Fractals on Your Computer, Micro No. 70, March 1984.

The Program

The calculation portion of this program will work in almost any BASIC. The plotting assumes the Apple II routines to HOME (clear screen and home cursor), VTAB and HTAB (to position the cursor) and HPLOT (to plot a line between two points). If your BASIC does not have these routines, you must supply them. Commodore 64 owners: Loren Wright's Fast Bit Map Plotting, appearing in this issue, and Fast Line Plotting, appearing in next issue, will provide the necessary routines to implement the Binary Tree Plotting.



LEFT ANGLE= 144
RIGHT ANGLE= 144
LEFT GROWTH FACTOR= .618
RIGHT GROWTH FACTOR= .618
SCALE= 125

Figure 3

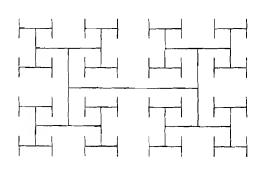
```
1 REM *** BINARY TREE PLOTTING
  5 ONERR GOTO 600:
     REM *** IF TREE IS TOO LARGE TO FIT ON THE
     SCREEN, PROMPT FOR A LARGER SCALE
 1Ø DIM X1(128): DIM Y1(128): DIM X2(128):
     DIM Y2(128)
    DIM A1(128): DIM A2(128): DIM L1(128):
     DIM L2(128)
    HOME: INPUT "GENERATIONS?(RANGE1-7) ";G
 40 IF G > 7 OR G < 1 THEN GOTO 30
 50 INPUT "LEFT ANGLE? "; LA
 60 INPUT "RIGHT ANGLE? "; RA
 69 REM *** CONVERT FROM DEGREES TO RADIANS
   LA = LA * 3.14159266 / 18Ø:
     RA = RA * 3.14159266 / 18Ø
8Ø INPUT "LEFT GROWTH FACTOR? "; LGF
   INPUT "RIGHT GROWTH FACTOR? "; RGF
90
    INPUT "SCALE? ";SCL
100
110 HGR2: REM *** CLEAR GRAPHICS SCREEN
    REM *** INITIALIZE STARTING POINT TO SLIGHTLY
     ABOVE THE CENTER OF THE SCREEN
12\emptyset \quad Y1(\emptyset) = 86:X1(\emptyset) = 14\emptyset
140 L1(\emptyset) = SCL:A1(\emptyset) = \emptyset
15Ø SIZE = 1
16\emptyset FOR A = 1 TO G
17Ø SIZE = SIZE * 2
171 REM *** SIZE IS THE NUMBER OF END POINTS OF
     THE GENERATION BEING DRAWN
18Ø FOR I = Ø TO SIZE / 2 - 1
185 RI = 2 * I:LI = 2 * I + 1
     REM *** RI IS THE INDEX OF THE RIGHT BRANCH;
     LI IS THE INDEX OF THE LEFT
189
     REM *** CALCULATE ANGLES OF RIGHT AND LEFT
     BRANCHES
190
   A2(RI) = A1(I) + RA:A2(LI) = A1(I) - LA
199 REM *** CALCULATE LENGTH OF RIGHT AND LEFT
     BRANCHES
   L2(RI) = L1(I) * RGF:L2(LI) = L1(I) * LGF
209 REM *** CALCULATE X AND Y COORDINATES OF END
```

```
0
229 REM *** PLOT RIGHT BRANCH
23Ø HPLOT X1(I),Y1(I) TO X2(RI),Y2(RI)
         *** CALCULATE X AND Y COORDIATES OF END
                                                    O
    POINT OF LEFT BRANCH
    X2(LI) = X1(I) + SIN(A2(LI)) * L2(LI)
250 \text{ Y2(LI)} = \text{Y1(I)} + \text{COS (A2(LI))} * \text{L2(LI)}
259
         *** PLOT LEFT BRANCH
    REM
                                                    0
26Ø
    HPLOT X1(I), Y1(I) TO X2(LI), Y2(LI)
27Ø
    NEXT I
279
    REM *** SHIFT ARRAY VALUES FOR CALCULATION OF
    NEXT GENERATION
                                                    0
    FOR I = \emptyset TO SIZE - 1
280
    X1(I) = X2(I):Y1(I) = Y2(I)
290
3ØØ
    L1(I) = L2(I):A1(I) = A2(I)
31Ø NEXT I
                                                    \circ
32Ø
    NEXT A
    REM *** WAIT FOR A KEY TO BE PRESSED,
329
     THEN CLEAR SCREEN
                                                    0
330
    GET A$: TEXT : HOME
    PRINT "INPUT:"
340
    VTAB 6: HTAB 1Ø: PRINT "Q-TO QUIT"
350
36Ø
    VTAB 10: HTAB 10: PRINT "P-TO PRINT TREE"
                                                    0
    VTAB 14: HTAB 10: PRINT "N-FOR NEW TREE"
365
    GET AS: IF AS = "P" THEN GOTO 400
370
375 IF A$ = "N" THEN HOME : GOTO 30
                                                    0
38Ø IF A$ < > "Q" THEN GOTO 33Ø
390
399
    REM *** PROVIDE APPROPRIATE COMMAND FOR YOUR
    PRINTER
                                                     0
    PR# 1: PRINT CHR$ (9); "G2DL"
400
41Ø PRINT "LEFT ANGLE= "; LA * 18Ø / 3.14159266
42Ø PRINT "RIGHT ANGLE= ";RA * 18Ø / 3.14159266
                                                     0
430 PRINT "LEFT GROWTH FACTOR= ";LGF
44Ø PRINT "RIGHT GROWTH FACTOR= "; RGF
450 PRINT "SCALE= "; SCL
46Ø PR# Ø
                                                    0
47Ø HOME : GOTO 34Ø
    TEXT : HOME :
    PRINT "TREE PARTIALLY OFF SCREEN.":
                                                    0
    PRINT "TRY AGAIN USING SMALLER SCALE":
    GOTO 100
```

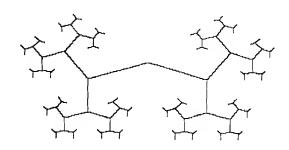
POINT OF RIGHT BRANCH

 $210 \times 2(RI) = X1(I) + SIN(A2(RI)) * L2(RI)$

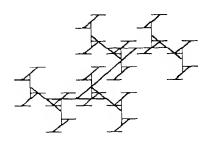
220 Y2(RI) = Y1(I) + COS (A2(RI)) * L2(RI)



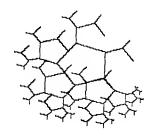
LEFT ANGLE= 90 RIGHT ANGLE= 90 LEFT GROWTH FACTOR= .707 RIGHT GROWTH FACTOR= .707 SCALE= 90



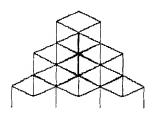
LEFT ANGLE= 72 RIGHT ANGLE= 72 LEFT GROWTH FACTOR= .618 RIGHT GROWTH FACTOR= .618 SCALE= 100



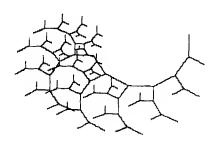
LEFT ANGLE= 45 RIGHT ANGLE= 135 LEFT GROWTH FACTOR= .707 RIGHT GROWTH FACTOR= .707 SCALE= 60



LEFT ANGLE= 72 RIGHT ANGLE= 36 LEFT GROWTH FACTOR= 1 RIGHT GROWTH FACTOR= .618 SCALE= 30



LEFT ANGLE= 120 RIGHT ANGLE= 120 LEFT GROWTH FACTOR= 1 RIGHT GROWTH FACTOR= 1 SCALE= 25



LEFT ANGLE= 90
RIGHT ANGLE= 30
LEFT GROWTH FACTOR= .707
RIGHT GROWTH FACTOR= 1
SCALE= 25

Additional Examples of Binary Tree Plotting

Portrait of a Serious Computerist Results of the June 1984 MICRO Survey

What is your	9.80e?	Approximatel	y how much have you spent on your
33%	AGE 30-39		rdware so far?
25	AGE 40-49	22%	\$1000-1999
20 20		19	\$2000-2999
29 14	AGE 20-29	16	• • • • • • • • • • • • • • • • • • • •
	AGE 50-59	=	\$3ØØØ-3999 \$6ØØ# 0000
5	AGE 60+	13	\$5000-9999
4	AGE -19	12	\$4000-4999
		7	\$5ØØ-999
What is your	coccupation?	7	\$10,000+
19%	Engineer	2	-\$ 5ØØ
19	Other		
17	Professor/teacher	Approximatel	y how much do you plan to spend on
16	Programmer/Analyst	your comput	er hardware in the next year?
11	Technician	34%	\$5ØØ999
6	Student	27	-\$5ØØ
6	Self Employed	23	\$1000-1999
3	Lawyer	6	\$2ØØØ-2999
ź	Doctor	2	\$3000-3999
1	Business person	2	\$4000-4999
-	business person	2	\$5000-9999
What to maxim	Commal advisables of 1 10	2	\$10,000+
•	formal educational level?	٤	דששש, שבק
34%	Bachelor's degree	176-4 -33141-	barra mada da manu barda mustam?
33	Advanced degree		ons have you made to your basic system?
16	High school graduate	82%	Disk drives
14	Associate degree	81	Printer
2	Fewer than 12 years	52	Modem
2	Para-professional degree	51	Parallel interface
		41	RAM cards
What is your	annual household income before taxes?	34	Serial interface
26%	\$30,000-39, 99 9	19	Z8Ø card
24	\$50,000+	15	Graphics Tablet
19	\$4Ø,ØØØ-49,999	4	Hard disk
17	\$20,000-29,999	3	68000 card
11	Less than \$20,000	2	68 0 9 card
	mputer(s) do you use?		onal hardware changes or upgrades do you
43%	Apple II	-	ke to your system?
38	Other	26%	Disk drives
37	Commodore 64	25	Modem
14	Atari	23	Printer
11	VIC	13	68000 card
1Ø	PET/CBM	13	Hard disk
8	OSI	13	Graphics Tablet
6	AIM	1Ø	RAM cards
6	KIM	7	Z8Ø card
5	Macintosin	5	Serial interface
5	SYM	Á	Parallel interface
4		1	6809 card
4	TRS-80 Color Computer Other 6502	-	COP, Cura
		Hove you ove	an constructed a computer computer board
4	Other 68 0 9	•	er constructed a computer, computer board,
In 3	About the state of		omputer equipment?
	use the above computers?	56%	No Van
94%	Home	41	Yes
51	Work		
	School School	Have you sw:	itched from one computer to another?
11			
11 3	Other	53 % 43	No Yes

Approximately how much have you spent on your computer software so far?

30% \$500-999 28 \$200-499

15 -\$200

14 \$1000-1999

12 \$2000+

Approximately how much do you expect to spend on computer software in the next year?

39% \$200-499 34 -\$200 17 \$500-999 5 \$1000-1999 3 \$2000+

How do you use your computer equipment?

74% Word processing

66 Hobby

57 Software development

52 Entertainment

49 Business

42 Database management

40 Educations

35 Telecommunications

35 Graphics

19 Hardware development

11 Other

What languages do you use?

96% BASIC

72 65Ø2 Assembler

30 Pascal

26 Forth

16 Fortran

15 Other

13 LOGO

11 (

9 68000 Assembler

7 COBOL

5 6809 Assembler

3 APL

3 LISP

If you write programs, what type of programming do you spend most of your time developing?

42% Software development utilities

37 Other

29 Business applications

7 Games

How would you rate your present microcomputer knowledge:

Software:

51% Intermediate

44 Advanced

5 Elementary

Hardware:

53% Intermediate

28 Advanced

18 Elementary

Is MICRO:

55% Just right

31 Not technical enough

4 Too technical

A Few Notes

The 1984 MICRO Survey Form was printed as a self-mailer in the June 1984 issue. The results were converted to computer-readable form using an Apple II and an Apple Graphics Tablet. We have presented here the results that we felt would be of interest to our readers. We have sorted each question so that the answers are ranked in descending order to make the results easier to follow. All figures are a percentage of the total responses to each question. Since the results are rounded, they may not always equal exactly 100%. Some may total less than 100% if some readers did not answer the question. Other questions, in which readers might make several choices, will add up to over 100%. For example, "What microcomputer(s) do you use?" responses total 195%, indicating that MICRO readers use, on the average, two (2) microcomputers.

Some Significant Results

Some of the results that I find particularly significant in characterizing the MICRO reader are:

age (76% are 30 or older)

education level [75% have a Bachelor or Advanced degree]

use of microcomputers at work [51%] as well as at home [94%]

amount invested (48% have spent over \$3000)

programming knowledge (95% rate themselves as intermediate or advanced)

programming languages (72% use 6502 assembler, 30% Pascal, 26% FORTH)

hardware skills (41% have built major computer projects, 81% rate themselves intermediate or advanced)

This is a pretty heavy group!

Conclusions

We are pleased to see that our readership is so qualified, that they really are, for the most part, "Serious Computerists". For the 55% of you that think MICRO is technically ''just right'', we are glad that you are satisified. For the 31% reporting that we are "not technical enough", wait until you see what we have in store for you in upcoming issues! Some sophisticated theory and programs for adding shading to graphics. A 'build-it-from-scratch' 68000 co-processor to work with your Apple or Commodore 64, complete with a 68000 monitor and a 6502 cross assembler. And, if you are into mathematical applications, a very high-level series on fast equation solving. And for the 4% who find us "too technical", well, there are literally hundreds of other computer magazines out there ready to serve your needs. MICRO will continue to strive to serve those of you who are really serious about microcomputing.

FAST BIT MAP PLOTTING for the Commodore 64

by Loren W. Wright Dracut, Massachusetts

Introduction

The Commodore 64 has a very capable system of bit map graphics. In the highresolution mode two or more colors are available, and the resolution is 320 dots across by 200 vertically. In the multicolor mode four or more colors are available, with the horizontal resolution reduced to 160 dots. However, access to bit-map graphics from BASIC is poor, requiring a series of cryptic POKEs, PEEKs, ANDs, and ORs, instead of PLOT, GRAPHICS, and COLOR commands. Even worse, BASIC is very slow at performing the necessary tasks. Clearing the bit map (8,000 bytes) takes 30 seconds, and even changing one of the plot colors takes several seconds. I presented simple machine-language routines for these tasks in a Commodore Compass article (MICRO 68:43, Jan 1984) and these routines have been reassembled to work with XYPLOT and BMCALC.

Another area where a machinelanguage program can make a big difference is in the actual plotting of points on a bit map screen. In this article I present a routine to calculate the appropriate byte in bit-map memory, given the x- and y-coordinates of the desired point. First, for those who want to ''load-and-run,'' I provide a sample driver routine that uses the values of the BASIC variables X, Y, and C to plot, erase, or toggle points on the HiRes bit-map screen. Those who would like to see a demonstration of some simple machine-language arithmetic will want to read the detailed discussion of the BMCALC routine later in this article.

The calculation routine may also be used to convert sprite positions to use a sprite as a pointer or pen. Other uses include converting sprites or characters to bit-map images, and vice versa. Routines for these applications may be the subjects of future articles.

The Commodore 64 has great high resolution color capabilities built-in.

Assembly level routines are presented to support fast bit map plotting and to provide the basis for a hi-res support package.

The XYPLOT Routine

XYPLOT works equally well with HiRes and multicolor. Once you have executed INIT the points will be plotted automatically in the current mode.

Using XYPLOT

Be sure you have XYPLOT properly installed, either with a direct memory load or with BASIC READ/DATA routine. After your bit map mode is in effect, you must initialize once with SYS 49216. The INIT routine sets up the proper data for both the clear routines and BMCALC. Then all you need to do is set the BASIC variable X within the allowable range of 0 to 319 [or 0 to 159 for multicolor], the variable Y between 0 and 199, and variable C to 0, 1, or 2 [0, 1, 2, 3, or 4 for multicolor]. Then SYS 49219. That's it!

HiRes:

C0 plots a point in background color. C1 plots a point in foreground color. C2 toggles the point, i.e., a background point becomes a foreground point, and vice versa.

Multicolor:

C0 plots a point in background color (53281).

C1 plots a point in Color 1.

C2 plots a point in Color 2.

C3 plots a point in Color 3.

C4 toggles the point: 0 becomes 3, 1 becomes 2, 2 becomes 1, and 3 becomes 0.

Any other value for C causes nothing to happen. By the way, this is the same plot-type useage as SIMON's BASIC.

A sample plotting program:

WW=49152 SYS WW+64 FOR X=Ø TO 199 Y=X SYS WW+67 NEXT X

This makes a straight diagonal line up from the lower left corner. The routine assumes a lower left orgin. Failure to perform INIT, or performing it at the wrong time, is the only possibly fatal error.

How it Works

The routine must perform the following tasks:

- 1. Determine the values of BASIC variables X, Y, and C.
- 2. Invert Y by subtracting it from 199.
- 3. Set up BMCALC and execute it.
- 4. Read the contents of the calculated byte and modify it according to the value of C.

The subroutine VARSET uses three C-64 ROM routines to 1) find where the value of a variable is stored, 2) load it into the floating-point accumulator, and 3) convert it into an integer. The floating-point variables X, Y, and C are set up by storing the ASCII of the appropriate letter into \$45 and \$00 into \$46

Y is inverted by subtracting it from 199. Since the values of X increase from left to right, while the bits increase from right to left within a bit-map byte, the bit position in HiRes mode is calculated by first ANDing with 7, then EORing with 7.

For HiRes mode, a table HRTBL of eight bit masks is used to calculate the new value to store back into bit map memory. The bit position is used as an index into the table.

Setting a point to foreground color means ORing the table value. Setting a point to background color means EORing the table value with 255 and ANDing the result with the bit-map byte. Toggling a point is simply a matter of EORing with the table value.

In multicolor mode, the proper bit pair is calculated by ANDing and then EORing the X-coordinate with 3. The BMCALC routine takes X values in the range 0 to 319, so the multicolor X value gets temporarily multiplied by 2 while BMCALC is using it. A table of four bit-pair masks is used to save the contents of the other three bit pairs in the byte. In the toggle mode, another table is used to read the current contents of the bit pair so that it can be in verted.

The BMCALC Routine

The Problem

For most plotting on the bit-map screen, it is convenient to use it as a big sheet of graph paper with x-coordinates running from 0 on the left to 319 on the

right, and y-coordinates running from 0 at the bottom to 199 at the top. However, bit-map memory is not organized that way. Instead, it is organized as if the memory were character definitions. Each byte codes for a row of eight pixels.

```
BYTE000 BYTE009 ... BYTE312
BYTE001 BYTE009 ... BYTE313
BYTE002 BYTE010 ... BYTE314
BYTE003 BYTE011 ... BYTE315
BYTE004 BYTE012 ... BYTE316
BYTE005 BYTE013 ... BYTE317
BYTE006 BYTE014 ... BYTE318
BYTE007 BYTE015 ... BYTE319
BYTE320 BYTE328 ... BYTE632
```

Having bit-map memory organized this way is convenient for setting colors, since screen memory (which normally does hold characters) is used for the colors. It is not very convenient for plotting points, though. Following are the calculations required in BASIC to convert an x,y point to the appropriate byte and bit in HiRes bit-map memory:

BMLOC=start of bit-map memory
ROW=INT(Y/8)
COLUMN=INT(X/8)
LINE=Y AND 7
BIT=7-(X AND 7)
BYTE=BMLOC+ROW*32Ø+
COLUMN*8+LINE

To set a pixel to the foreground color:

POKE BYTE, PEEK (BYTE) OR 2 TBIT

To set a pixel to the background color:

POKE BYTE, PEEK(BYTE) AND (255-2†BIT)

No wonder plotting a point takes so long! The machine-language routine does exactly the same thing, only much faster. In describing the program, I will use the same terminology as above.

ROW and COLUMN describe the character position of the point. ROW can have values from 0 to 24, and COLUMN can have values from 0 to 39. There are 1000 different row and column combinations, just like a character screen. As well as helping in calculating the value of BYTE, these can be used to calculate the appropriate bytes in character and color memory for setting and changing colors.

LINE describes the position (0 to 7) within the "character." For instance, byte 322 in the diagram above has a LINE value of 2.

Putting the Address Together

Each address consists of 16 bits, or two 8-bit bytes. The machine language program puts the address together from different sources.

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

These two bits are determined by the bank being used by the 6567 (VIC II). The bank is controlled by bits 0 & 1 of port A of one of the 6526's (CIA). However, these bits are inverted [3 indicates bank 0, 2 indicates bank 1, etc.], so there are two steps involved in the calculation:

- 1. Invert the two bits.
- 2. Get them from positions 0 & 1 to positions 14 & 15 of the address, or positions 6 & 7 of its high byte.

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

This bit is determined by the location of the bit map within the bank. If the bit map is in the lower 8K of the 16K bank, then bit 13 must be 0. If it is in the upper 8K, then the bit must be 1. Bit 3 of register \$18 in the 6567 (address \$D018 or 53272) controls this.

The INIT routine performs the calculation of bits 13, 14, & 15. The bank and bit-map location are never changed in the middle of a plotting session, so some speed can be gained by separating these calculations and performing them once at the beginning. INIT must be performed while the bitmap screen is in effect, though. Performing INIT while in normal character mode will likely result in points getting plotted in page 0, the stack, and your BASIC program! The result is stored in BMLOC, and this value is ORed into the high byte BMPTR1 near the end of the main calculation routine. In addition, INIT calculates the start of screen memory and saves it for use by the clearing routines.

15 14 13 **12** 11 **10 9 8 7 6 5 4 3 2 1 0**

Calculating these bits occupies most of the BMCALC routine. The following expression represents what we want to end up with in these bits:

32Ø*ROW + 8*COLUMN

Multiplication and division in machine language are not the easiest things, but it helps when one of the numbers involved is a power of two. Then all you need to do is shift the other number left to multiply and right to divide. For instance, to multiply by 64, just shift the

other number six places to the left (64=2↑6). A 16-bit multiplication works automatically, if you shift the low byte, immediately followed by shift of the high byte. The high byte must be shifted using a 'rotate' instruction, so that the carry will transfer the bit pushed out of the low byte.

ASL of low byte:

ROL of high byte:

(Carry from low byte)

You may have noticed that 320 is not a power of two. However, it does equal 256+64, so that simplifies things.

Before we perform the above calculation, though, we must have values for ROW and COLUMN. ROW is INT(YPOS/8) and COLUMN is INT(XPOS/8). All we have to do is shift each number three bits to the right. The INT operation occurs automatically when the right three bits fall off without being saved! The only complication is that XPOS is contained in two bytes. By first shifting the accumulator, which starts with the value of XHI, followed by COLUMN, which starts with the value of XPOS, that 9th bit is automatically shifted into the low byte. (This time the rotate instruction is used on the low byte, so that it will pick up the carry, containing the bit pushed from the high byte. For convenience, ROW, which starts with the value of YPOS, is shifted at the same time. COLUMN and ROW end up with the correct values for color calculations.

Acc

COLUMN

(value of XHI)

(val of XPOS)

ROW (value of YPOS)

YYYYYYY

Result after 3 shifts:

Acc (discarded) COLUMN

øøøøøøøø øøxxxxxx

ROW

ØØØYYYYY

If we rewrite the expression for calculating bits 3-12, it becomes:

256*ROW + 64*ROW + 8*COLUMN

The first and third parts of the calculation are trivial. To get 256*ROW, all we have to do is add it to the high byte (BMPTR+1), rather than the low byte (BMPTR) of the address. To get 8*COLUMN take XPOS and remove the three low bits. COLUMN was calculated by dividing XPOS by 8, so the only difference between XPOS and 8*COLUMN is the three lost bits.

64*COLUMN is only difficult because it involves shifting across two bytes. As I explained above, you shift the low byte first. The bit pushed off the left end goes into the carry. If you then perform a rotate on the high byte, the carry is shifted into bit 0 of the high byte. Six successive shift and rotate sequences results in a multiplication by 64.

BMPTR+1 (starts=0) Acc (val of ROW)

After 6 shift & rotate sequences:

BMPTR+1

Accumulator

Ø Ø Ø Ø Ø Y Y Y Y Ø Ø Ø Ø Ø Ø (Sharp readers may have noticed that I could have accomplished the same thing with only two shifts in the opposite direction, but that's a little confusing. 64*ROW256*ROW/4

All that's left is putting the pieces together. This is accomplished by adding up the components. Then BMLOC is ORed into BMPTR + 1.

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

The final three bits are LINE, the byte (0-7) within the "character". This is calculated by ANDing 7 with YPOS. LINE is ORed into BMPTR.

Applying BMCALC

The simplest way to use BMCALC from BASIC (without a machine language driver such as XYPLOT) is outlined below. The bit map should already be set up and protected, and probably cleared.

- 1. Perform INIT with SYS 49216 as soon as the bit-map mode is entered, but not before. This needs to be done only once at the beginning of the program, unless you change banks or bit-map locations.
- 2. POKE 49168,X AND 255: POKE 49169,-(X>255): POKE 49170,Y
- 3. SYS 49222

- 4. BY=PEEK(251)+256*PEEK(252)
- 5. POKE BY, PEEK (BY) OR
 2†(7-(X AND 7))
 to plot a foreground point, or

POKE BY, PEEK(BY) AND 255-2†(7-(X AND 7))

to plot a background point. You can save a lot of time with a few enhancements to the above:

1. Substitute a variable for every constant:

F=255: P=256: Z=49222

2. Set up two arrays ahead of time:

FOR $I=\emptyset$ TO 7: $P(I)=2\uparrow(7-I)$: M(I)=255-P(I): NEXT I

Then, to plot a foreground point:

POKE BY, PEEK (BY) OR P(X AND 7)

To plot a background point:

POKEMBY, PEEK (BY) AND M(X AND 7)

Of course, the ultimate in speed is obtained by skipping BASIC altogether. You can write a very simple program that reads numbers from a table and stores them in the registers XPOS, XHI, and YPOS. Then enter at label PPLOT. A little extra caution is necessary to be sure everything is set up properly.

Enhancements

The most convenient way to use BMCALC from BASIC would be something like:

So to draw a vertical line, you could write:

FOR Y=Ø TO 199 SYS WW+88,5Ø,Y,1 NEXT Y

Writing such a driver is straightforward, but it takes a little more code. This technique will be covered in a future article.

Next Month

The power of machine language plotting is amplified with a machine-language line calculator program and a driver that automatically reads the values of BASIC variables X1, Y1, X2, Y2, and C. Fast line drawing makes a lot more possible, including animation of 3-D objects.

<u>ث بانٹ توجیم م</u>			- 37		
	;******	CØ7Ø AD ØØ DD INIT CØ73 49 Ø3		56576 #3	;CIA PORT A ;REVERSE BITS
	;* *	CØ75 A2 Ø6	LDX	-	; Ø & 1 (BANK)
0	;* BIT MAP CALCULATOR WITH *	CØ77 ØA LOOPØ	ASL		;SHIFT TO
	;* BASIC-VARIABLE DRIVER *	CØ78 CA	DEX		;POS 6 & 7
	;*	CØ79 DØ FC		LOOPØ	,
10	;* BY LOREN W. WRIGHT *	CØ7B 8D 1Ø CØ	-	BMLOC	
	;*	CØ7E 8D 11 CØ		SCRHI	
-	;**********************	CØ81 A9 Ø8	LDA		
	;	CØ83 2D 18 DØ		53272	;BIT MAP POS
O ^{CØ4Ø}	POINTR = \$FB ;ZERO-PAGE POINTER	CØ86 FØ Ø2		NEXT1	; WITHIN BANK
	;	CØ88 A9 2Ø			ØØØ ;LOW 8K
	;\$CØØØ-\$CØØF RESERVED FOR USER	CØ8A ØD 1Ø CØ NEXT1		BMLOC	SET BIT 5 IF
	;	CØ8D 8D 10 CØ	STA	BMLOC	;TOP 8K
0	;SYSTEM CONSTANTS	CØ9Ø AD 18 DØ	LDA	53272	GET SCREEN LOC
00/0	DMTOO MOGICA .COMADO DIO MAD (UI)	CØ93 29 FØ	AND	#%111100	ØØØ
CØ4Ø	BMLOC = \$CØ1Ø ;START BIT MAP (HI)	CØ95 4A	LSR	A	;DIVIDE BY 4
OCØ4Ø	SCRHI = BMLOC+1 ;START SCREEN MEM (HI)	CØ96 4A	LSR	A	
CØ4Ø	MCFLAG = BMLOC+2 ; MC ON=\$10OFF=\$00	CØ97 ØD 11 CØ	ORA	SCRHI	;OR IN BANK #
CØ4Ø	PMODE = BMLOC+3 ;PLOT MODE OR COLOR	CØ9A 8D 11 CØ	STA	SCRHI	
0	; .CENTEDAT DIEDDOSE AND TEMPORARY	CØ9D AD 16 DØ	LDA	5327Ø	
	;GENERAL-PURPOSE AND TEMPORARY	CØAØ 29 1Ø	AND	# \$1Ø	; CHECK FOR
CØ4Ø	MASK = BMLOC+4	CØA2 8D 12 CØ	STA	MCFLAG	; MULTICOLOR
CØ4Ø	TEMP = BMLOC+5	CØA5 6Ø	RTS		
OCØ4Ø	ENDHI = TEMP	;			
CØ4Ø	PATTRN = BMLOC+6	•			AP SCREEN
CØ4Ø	FCOLOR = PATTRN	; FROM	BASIC	VARIABLI	ES X, Y, & C
0	;	;			
10	;INFO FOR CURRENT BIT-MAP POINT	CØA6 A9 58 XYPLOT			;SET UP BASIC
	;	CØA8 85 45		\$45	; VAR X
CØ4Ø	XPOS = \$CØ18 ; LOW 8 BITS	CØAA A9 ØØ		#Ø	
OCØ4Ø	XHI = XPOS+1 ;9TH BIT	CØAC 85 46		\$46	
CØ4Ø	YPOS = XPOS+2 ;TOP LEFT ORIGIN	CØAE 20 7D C1		VARSET	
CØ4Ø	YHI = XPOS+3 ; ERROR CHECKING	CØB1 A5 64		\$64	
CØ4Ø	COLUMN = XPOS+4 ; CHARACTER COLUMN	CØB3 8D 19 CØ		XHI	
OCØ4Ø	ROW = XPOS+5 ; CHARACTER ROW	CØB6 A5 65		\$65	
	, added adder property pop tive data	CØB8 8D 18 CØ		XPOS	ADM IND DAGEO
	;\$CØ3Ø-\$CØ3F RESERVED FOR LINE CALC	CØBB A9 59		# "Y "	;SET UP BASIC
0	;USAGE NEXT MONTH	CØBD 85 45 CØBF 2Ø 7D C1		\$45	; VARIABLE Y
1	; ;*	CØC2 A9 C7		#199	;\$46 IS ZERO ;INVERT Y TOP
	;* VECTORS FOR ROUTINES	CØC4 38	SEC	π⊥フフ	; TO BOTTOM
	;*	CØC5 E5 65		\$65	; FOR LOWER-LEFT
O _{CØ4Ø}	*= \$CØ4Ø	CØC7 8D 1A CØ		YPOS	; ORIGIN
1	;	CØCA A9 ØØ	LDA		, 0
. CØ4Ø 4C 7Ø CØ	JINITV JMP INIT	CØCC 8D 1B CØ		YHI	
0	; INITIALIZATION	CØCF A9 43			;SET UP VAR C
CØ43 4C A6 CØ		CØD1 85 45			;\$46 IS STILL Ø
]	; USES BASIC X,Y & C TO PLOT PT	CØD3 20 7D C1		VARSET	,. = ==
CØ46 4C BB C:	1 CALCV JMP BMCALC	;			
	; USES XPOS,XHI,YPOS	CØD6 AD 12 CØ PPLOT	LDA	MCFLAG	; CHECK FOR
CØ49 4C 82 C		CØD9 DØ 3D			; MULTICOLOR
	; USES BASIC X1,Y1,X2,Y2,C TO DRAW LINE	;			
Ccø4c 4c ø8 c	PHCLRV JMP HCLEAR	CØDB 2Ø 8B C1 HRPLOT	JSR	ERRCHK	
	; FILL BIT MAP WITH PATTERN	CØDE DØ 37		HRERRX	
CØ4F 4C 2E C2		CØEØ 2Ø BB C1	JSR	BMCALC	;CALCULATE
0	; FILL COLOR MEM WITH COLOR				; BIT MAP BYTE
OCØ52 4C 3D C	2 SET1V JMP SET1	CØE3 AD 18 CØ		XPOS	
1	; FILL SCREEN MSB-4 WITH COLOR	CØE6 29 Ø7	AND		
CØ55 4C 4E C2		CØE8 49 Ø7	EOR	#7	;LEFT TO RIGHT
0	; FILL SCREEN LSB-4 WITH COLOR	CØEA AA	XAT		_
1	, TEDE MIDOUAL ACCOR DECEDED TO	CØEB BD 6D C1		HRTABL,	(
}	;HERE THROUGH \$CØ6F RESERVED FOR	CØEE 8D 14 CØ		MASK	Drom More Till
0	;USER'S VECTORS	CØF1 AC 13 CØ			;PLOT MODE IN Y
1	OATOUTAMES DIM HAD SMADE EDOM	CØF4 A2 ØØ	LDX		V) ADM AIRCRIT
ĺ	;CALCULATES BIT MAP START FROM	CØF6 A1 FB	LUA		X) ;GET CURRENT
	; BANK SELECTION	oden od do modore	CDV		; BIT-MAP BYTE
0	; & BIT MAP LOCATION	CØF8 CØ Ø2 TOGGLE			;TOGGLE MODE
	;CALCULATES SCREEN MEM START	CØFA DØ Ø5 CØFC 4D 14 CØ		FGPLOT MASK	
CØ7Ø	; *= \$CØ7Ø				
W/W	*= \$CØ7Ø	CØFF 9Ø 14	טטפ	FINIS	

C1Ø1 CØ Ø1 FGPLOT CPY #1 ;FOREGROUND MODE	C19Ø 9Ø Ø9 BCC YCHEK
C1Ø3 DØ Ø5 BNE BGPLOT	C192 00 16 BNE ERRTRN
C1Ø5 ØD 14 CØ ORA MASK	
C108 90 0B BCC FINIS	C194 AD 18 CØ LDA XPOS O C197 C9 4Ø CMP #319-256+1
;	C199 BØ ØF BCS ERRTRN
C1ØA CØ ØØ BGPLOT CPY #Ø ;BACKGND/ERASE MOD	
C1ØC DØ Ø7 BNE FINIS ;NO CHANGE IF > 2	C19B AD 1B CØ YCHEK LDA YHI
CIØE AD 14 CØ LDA MASK ; OR < Ø	C19E DØ ØA BNE ERRTRN
C111 49 FF EOR #%11111111	
C113 21 FB AND (POINTR,X)	C1AØ AD 1A CØ LDA YPOS C1A3 C9 C8 CMP #199+1
	C1A3 C9 C8 CMP #199+1 C1A5 BØ Ø3 BCS ERRTRN O
; C115 81 FB FINIS STA (POINTR,X);STORE NEW	כש עם לאנט בתתומו -
C117 6Ø HRERRX RTS ; VERSION	; C1A7 A9 ØØ NOERR LDA #Ø
	■
; C118 2Ø AD C1 MCPLOT JSR MCERCK	
C11B DØ 3E BNE MCERRX	; CIAN AO RE EDDEDNI IDA MORE
	C1AA A9 FF ERRTRN LDA #\$FF C1AC 60 RTS
C11D ØE 18 CØ ASL XPOS ;SEND BMCALC 2*X C12Ø 2E 19 CØ ROL XHI	0
C123 20 BB C1 JSR BMCALC	CAAD AD AC ON MORDON ADA WILL
	C1AD AD 19 CØ MCERCK LDA XHI
	C1BØ DØ F8 BNE ERRTRN
	C1B2 AD 18 CØ LDA XPOS O
C12C AD 18 CØ LDA XPOS	C1B5 C9 AØ CMP #159+1
C12F 29 Ø3 AND #3	C1B7 BØ F1 BCS ERRTRN
C131 49 Ø3 EOR #3 ;MASK CONTAINS	C1B9 90 E0 BCC YCHEK
C12C AD 18 CØ LDA XPOS C12F 29 Ø3 AND #3 C131 49 Ø3 EOR #3 ;MASK CONTAINS C133 8D 14 CØ STA MASK ; BIT-PAIR POS. C136 AD 13 CØ LDA PMODE ;Ø-3 FOR COLORS,	, 0
C136 AD 13 CØ LDA PMODE ;Ø-3 FOR COLORS,	;CALCULATE BYTE FROM XHI,XPOS & YPOS
C139 C9 Ø4 CMP #4 ; 4 TO TOGGLE C13B FØ 1F BEQ MCTOGL	; COLUMN & ROW MAINTAINED
	; FOR CHAR & COLOR CALCULATIONS
C13D BØ 1C BCS MCERRX	din in in an ad an area
C13F AE 14 CØ LDX MASK	C1BB AD 18 CØ BMCALC LDA XPOS
C142 FØ Ø5 BEQ MCNEXT	C1BE 8D 1C CØ STA COLUMN
C144 ØA MCLOOP ASL A ;SHIFT PMODE TO	C1C1 AD 1A CØ LDA YPOS O
C145 ØA ASL A ; PROPER BIT PAIR	C1C4 8D 1D CØ STA ROW
C146 CA DEX	C1C7 AD 19 CØ LDA XHI C1CA A2 Ø3 LDX #3 ;INTEGER DIVIDE
C147 DØ FB BNE MCLOOP	
;	C1CC 4A LOOPB LSR A ; BY 8 O
C149 8D 15 CØ MCNEXT STA TEMP ; NEW PIXEL DATA	C1CD 6E 1C CØ ROR COLUMN ;9TH BIT OF C1DØ 4E 1D CØ LSR ROW ; XPOS FROM XHI C1D3 CA DEX
C14C A1 FB LDA (POINTR,X) ;GET CURRENT	C1DØ 4E 1D CØ LSR ROW ; XPOS FROM XHI
C14E AE 14 CØ LDX MASK ; BM BYTE	
C151 3D 75 C1 AND SVTABL,X ;SAVE OTHER	C1D4 DØ F6 BNE LOOPB
C151 3D 75 C1 AND SVTABL,X ;SAVE OTHER C154 ØD 15 CØ ORA TEMP ; 3 BIT PAIRS C157 A2 ØØ LDX #Ø	C1D4 DØ F6 BNE LOOPB C1D6 A9 ØØ LDA #Ø C1D8 85 FC STA POINTR+1
C159 81 FB STA (POINTR,X)	C1DA A2 Ø6 LDX #6 O
) OASD (d. NODDDY DEG	C1DC AD 1D CØ LDA ROW ; MULTIPLY BY 64
C15B 6Ø MCERRX RTS	C1DF ØA LOOPC ASL A
; C15C A2 dd - WOTCOT - TDV - 4d	C1EØ 26 FC ROL POINTR+1
C15C A2 ØØ MCTOGL LDX #Ø	C1E2 CA DEX
C15E A1 FB LDA (POINTR,X)	C1E3 DØ FA BNE LOOPC
C16Ø AE 14 CØ LDX MASK	C1E5 85 FB STA POINTR
C163 3D 79 C1 AND STTABL,X	C1E7 AD 18 CØ LDA XPOS O
C166 5D 79 C1 EOR STTABL,X	C1EA 29 F8 AND #%11111000 ;SAME AS
C169 A2 ØØ LDX #Ø	C1EC 18 CLC ; 8 * COLUMN
C16B FØ DC BEQ MCNEXT ;ALWAYS	C1ED 65 FB ADC POINTR
; C1(D d1 d2 d/ UDTADI DVTT dd1 dd2 dd/ dd0 d1d	CLEF 85 FB SIA POINIR
C16D Ø1 Ø2 Ø4 HRTABL .BYTE \$Ø1,\$Ø2,\$Ø4,\$Ø8,\$1Ø	C1F1 A5 FC LDA POINTR+1
C172 20 40 80 .BYTE \$20,\$40,\$80	C1F3 6D 1D CØ ADC ROW ;SAME AS +256*ROW
C175 FC F3 CF SVTABL BYTE \$FC,\$F3,\$CF,\$3F	C1F6 6D 19 CØ ADC XHI
C179 Ø3 ØC 3Ø STTABL .BYTE \$Ø3,\$ØC,\$3Ø,\$CØ	C1F9 ØD 1Ø CØ ORA BMLOC ;BITS 5, 6, & 7
;	C1FC 85 FC STA POINTR+1; FROM INIT
; VARIABLE NAME IN \$45,\$46	C1FE AD 1A CØ LDA YPOS
;RETURNS INTEGER IN \$64(HI),\$65(LO)	C201 29 07 AND #%00000111 ;GET LINE O
Compared the new value of the compared to the	C203 05 FB ORA POINTR ; WITHIN CHAR ROW
C17D 2Ø E7 BØ VARSET JSR \$BØE7 ; FIND VARIABLE	C2Ø5 85 FB STA POINTR
C18Ø A5 47 LDA \$47 ; (ROM ROUTINE)	C2Ø7 6Ø : RTS O
C182 A4 48 LDY \$48 ; LOAD FAC #1 W/	;*clearing routines
C184 20 A2 BB JSR \$BBA2 ; VALUE (ROM)	;*
C187 2Ø 9B BC	ATMIT MICT HAVE DEEN DESCRIPT
C18A 6Ø RTS ; H-\$64,L-\$65 (ROM)	;*INIT MUST HAVE BEEN PERFORMED ;* AND \$CØ18 MUST CONTAIN COLOR
;	;* OR PATTERN
C18B AD 19 CØ ERRCHK LDA XHI	, (1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
C18E C9 Ø1 CMP #1	

```
; ENTRY TO SET BIT
  C208 AD 10 CO HCLEAR
                          LDA
                              BMLOC
  C2ØB 85 FC
                         STA
                              POINTR+1 ; MAP TO PATTERN
  C2ØD 18
                          CLC
                                         ;SET UP POINTR
O C2ØE 69 2Ø
                          ADC
                              #$2Ø
                                         ; & ENDHI
  C21Ø 8D 15 CØ
                         STA
                              ENDHI
  C213 A9 ØØ
                              #0
                          LDA
O C215 85 FB
                         STA POINTR
  C217 AØ ØØ
                HMAIN
                         LDY #Ø
  C219 AD 16 CØ HLOOP
                          LDA PATTRN ; PAGE CLEAR USED
O C21C 91 FB
                INLOOP
                          STA (POINTR),Y; BY HCLEAR
  C21E C8
                          INY
                                           ; AND CCLEAR
  C21F DØ FB
                         BNE INLOOP
O C221 A5 FC
                         LDA POINTR+1 ; ADVANCE PAGE
                         CLC
  C224 69 Ø1
                          ADC
                              #1
  C226 85 FC
                         STA
                              POINTR+1
O C228 CD 15 CØ
                         CMP
                              ENDHI
  C22B DØ EC
                         BNE HLOOP
  C22D 6Ø
                         RTS
O C22E A9 D8
                 CCLEAR LDA #$D8
                                       ;ENTRY TO SET
                         STA POINTR+1 ; COLOR MEM TO
  C23Ø 85 FC
  C232 A9 ØØ
                         LDA #Ø
                                       ; COLOR-MC COLOR 11
O C234 85 FB
                         STA POINTR ; SETUP POINTER
                         LDA #$DC
                                       ; & ENDHI
  C236 A9 DC
                         STA ENDHI
  C238 8D 15 CØ
  C23B DØ DA
                         BNE HMAIN
                                       ; ALWAYS
  C23D AD 16 CØ SET1
                         LDA
                              FCOLOR ; ENTRY TO SET MC
                                       ; COLOR Ø1 &
  C24Ø ØA
                          ASL
                              Α
O C241 ØA
                                       ; HR BACKGROUND
                          ASL
                              Α
  C242 ØA
                         ASL
                              Α
  C243 ØA
                         ASI. A
  C244 8D 16 CØ
                          STA FCOLOR
O C247 A9 ØF
                         LDA #%ØØØØ1111 ;TO PRESERVE
                                         ; LOW 4 BITS
  C249 8D 14 CØ
                         STA MASK
                         BNE SETCOLOR ; ALWAYS
  C24C DØ Ø5
                 ; ENTRY TO SET MC COLOR 10 & HR
  C24E A9 FØ
                SET2
                         LDA #%11110000
  C25Ø 8D 14 CØ
                         STA MASK
  C253 AD 11 CØ SETCOLCR LDA SCRHI
                                         ;SET UP POINTR
                         STA POINTR+1 ; AND ENDHI
  C256 85 FC
  C258 18
                         CLC
O 0259 69 Ø3
                          ADC
                              #3
                          STA ENDHI
  C25B 8D 15 CØ
  C25E A9 ØØ
                          LDA
                              #Ø
O C26Ø 85 FB
                         STA
                              POINTR
  C262 A8
                         TAY
  C263 B1 FB
                CLOOP
                          LDA
                              (POINTR),Y ; TAKE WHAT'S
O C265 2D 14 CØ
                                       ; THERE, KEEP
                          AND
                              MASK
                              FCOLOR ; THE OTHER
  C268 ØD 16 CØ
                          ORA
  C26B 91 FB
                          STA
                              (POINTR),Y ; COLOR, CHANGE
O C26D C8 C26E FØ ØD
                                        ; PROPER 4 BITS
                          INY
                              NEXTPG
                                        ; AND PUT IT BACK
                          BEQ
                                       ;SCREEN+$3E7
  C27Ø CØ E8
                          CPY #$E8
  C272 DØ EF
                          BNE CLOOP
                                       ; IS END
O C274 A5 FC
                          LDA POINTR+1 ; TEST FOR
  C276 CD 15 CØ
                          CMP ENDHI
                                         ; LAST PAGE
  C279 DØ E8
                          BNE CLOOP
                                       ; CONTINUE IF NOT
  C27B FØ Ø4
                          BEQ DONE
  C27D E6 FC
                NEXTPG
                          INC POINTR+1 ; ADVANCE PAGE
  C27F DØ E2
                          BNE CLOOP
O
  C281 6Ø
                          RTS
                DONE
```

Sine Wave Demo

```
1Ø WW=49152
20 GOSUB 8000: REM SET UP SCREEN
3Ø SYS WW+64: REM INIT
40 POKE WW+22,0: SYS WW+76: REM CLEAR BIT-MAP
5Ø POKE WW+22,Ø: SYS WW+82: REM FGD=Ø
60 POKE WW+22,1: SYS WW+85: REM BGD=1
100 C=1: P=3.14159265
11Ø FOR X=Ø TO 319
12Ø Y=1ØØ+INT(SIN(X*P/16Ø)*95+.5)
13Ø SYS WW+67: REM PLOT POINT
140 NEXT X
900 GET T$:IF T$="" THEN 900
91Ø GOSUB 81ØØ
999 STOP
8000 REM HI-RES SETUP
8Ø1Ø POKE 56578, PEEK (56578) OR 3
8Ø2Ø POKE 56576, PEEK (56576) AND 252 OR 2
8Ø3Ø POKE 53272,PEEK(53272) AND 7 OR 12Ø
8Ø4Ø POKE 53265, PEEK (53265) OR 32
8Ø5Ø RETURN
8100 REM RESTORE CHAR SCREEN
811Ø POKE 56578, PEEK (56578) OR 3
812Ø POKE 56576, PEEK (56576) OR 3
813Ø POKE 53272, PEEK (53272) AND 7 OR 16
814Ø POKE 53265, PEEK (53265) AND 223
815Ø RETURN
```

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; NEXT MONTH!

Machine Language

Loops

by Chris Williams Ogden, Utah

Misconceptions About Machine Language Loops — Exposed

This is the latest in an informal series of articles on speed in assembly language programming. The first article was a presentation of techniques. This one is a discussion of a popular misconception about machine language loops.

Readers who are experienced machine language programmers are probably frowning right now in reaction to the title and that's good. It was meant to get their attention. It is they who are wrong about loops.

How? Well, like any other technical type, machine language programmers tend to use educated intuition in deciding how to perform a given task. That intuition is the product of experience. The solutions they've encountered in the past tend to get selected as the best solution for the problem at hand.

Fine. And yes, I know that's obvious. But it has a subtle ramification that quite literally has swept the industry. You see, there's a problem. Suppose those solutions encountered in the past were wrong?

Examine, if you will, the following sequence of 6502 assembly language instructions.

LDA \$VAL
STA \$VALSTR
LDA \$VAL+1
STA \$VALSTR+1
LDA \$VAL+2
STA \$VALSTR+2
LDA \$VALSTR+2
STA \$VALSTR+3

You've probably never seen that sort of thing before, especially if it had gone out to \$VAL+9 or \$VAL+10 or farther

No, most likely you've seen that operation done like so:

LDX #Ø4
LOOP LDA \$VAL,X
STA \$VALSTR,X
DEX
BNE LOOP

And some people would use ...

LDX #00
LOOP LDA \$VAL,X
STA \$VALSTR,X
INX
CPX #04
BNE LOOP

... though they shouldn't and, if they'd read my previous article on speed and counting down, they would have known better.

But back to the point. Which of the two ways of LOADing and STOREing do you prefer? Sure, you like the second one. Loops are elegant. They're popular. They're easier to type in. And your intuition tells you they're just plain superior.

Let's see. First, let's examine the memory storage in Figure 1.

The results there show a healthy memory savings for the loop. For a speed comparison, now look at Figure 2.

Hmmm, the byte ratio is 24/11 (24/13 for the wrong way) in favor of the loop and the speed ratio is 62/32 in favor of sequence code. Let's observe here that, if there is no inordinate value placed on either speed or memory (i.e., they're equally valuable), the larger memory ratio advantage of the loop is probably compelling and that would be the way to go. All who preferred the loop may congratulate themselves. Their intuition in this case was correct.

Now then, suppose there was only one LOAD-STORE pair as shown in

Bytes Used LDA \$VAL 3 STA \$VALSTR 3 LDA \$VAL+1 3 STA \$VALSTR+1 LDA \$VAL+2 STA \$VALSTR+2 LDA \$VAL+3 STA \$VALSTR+3 3 24 BYTES And for the loop: LDX #Ø4 LOOP LDA \$VAL,X 3 STA \$VALSTR,X 3 1 BNE LOOP 2 11 BYTES Or, if you insist on doing it wrong: LDX #ØØ LOOP LDA \$VAL,X STA \$VALSTR,X INX CPX #Ø4 BNE LOOP 13 BYTES Figure 1 Memory Usage

Figure 3. Would anyone use a loop here?

Machine Cycles	
LDA \$VAL	4
STA \$VALSTR	4
LDA \$VAL+1	4
STA \$VALSTR+1	4
LDA \$VAL+2	
STA \$VALSTR+2	4
LDA \$VAL+3	4
STA \$VALSTR+3	4
	32 CYCLES
And for the loop:	
LD X #Ø4	2
	2
LOOP LDA \$VAL,X	4
LOOP LDA \$VAL,X STA \$VALSTR,X	4
	4
STA \$VALSTR,X	4 5
STA \$VALSTR,X DEX	4 5 2
STA \$VALSTR,X DEX	4 5 2
STA \$VALSTR,X DEX BNE LOOP	4 5 2
STA \$VALSTR,X DEX BNE LOOP	4 5 2 4
STA \$VALSTR,X DEX BNE LOOP	4 5 2 4
STA \$VALSTR,X DEX BNE LOOP	4 5 2 4 15*4)=62 CYCLES
STA \$VALSTR,X DEX BNE LOOP 2+(4 5 2 4 15*4)=62 CYCLES

I hope not. The numbers clearly show the loop to be inferior in both memory used and speed.

So, the whole issue comes down to this question. At what point should you stop writing LOAD-STORE pairs and start writing loops?

I've asked this question of several assembly language competent friends and their answers are interesting, mainly because they were all the same.

"Use a loop when there's three or more pairs," they said, almost as one. "Three is the magic number."

I'll bet you agree.

Sorry. The right answer is two. Examine Figure 4.

You pass memory breakeven at 2 pairs and, indeed, have a one byte advantage there. The speed ratio is 2:1. At 3 pairs the memory advantage continues to grow and the speed ratio shrinks almost not at all. Since the speed ratio is essentially the same, the memory factor is decisive, and since we passed equality there at 2 pairs, then clearly that was the point at which to switch over to loops, not at 3 pairs.

This failure in intuition is disconcerting. One grows to depend on it in technical fields. It's usually not that

		\$VAL \$VALSTR	Used 3 3	Machine Cycles 4 4 ES 8 CYCLES	
The :	Loop	would be	e:		
LOOP	LDA STA DEX	#1 \$VAL \$VALSTR LOOP	1 2	2 4 2 4 ES 16 CYCLES	
Figu	re 3	The Sin	gle LOAD	-STORE Pair	

deceptive. I suspect it fails us in this case because a loop requires us to type 5 lines of code for 2 pairs as opposed to 4 lines of code for a sequence, even though the memory requirement is less. It's laziness changing our minds and warping our judgement here, not logic. Be aware of it.

For three LOAD-STORE pairs:

For two LOAD-STORE pairs:

	H	Bytes Ma	chine		LDA	\$VAL	3	4
	Ţ	Jsed C	ycles		STA	\$VALSTR	3	4
LDA :	\$VAL	3	4		LDA	\$VAL+1	3	4
STA	\$VALSTR	3	4		STA	\$VALSTR+	3	4
LDA :	\$VAL+1	3	4					
STA	\$VALSTR+1	3	4					
LDA	\$VAL+2	3	4				12 BYTES	16 CYCLES
STA	\$VALSTR+2	3	4					
				The	100 p	would be:		
		18 BYTES	24 CYCLES					
					LDX	#Ø2	2	2
he loop	would be:			LOOP	LDA	\$VAL,X	3	4
					STA	\$VALSTR,X	3	5
					DEX		1	2
LDX	#Ø3	2	2		BNE	LOOP	2	4
LOOP LDA	\$VAL,X	3	4					
STA	\$VALSTR,X	3	5					
DEX		1	2				11 BYTES	2+(15*2)=32 CYCLE
BNE	LOOP	2	4					
		11 BYTES	2+(15*3)=47 CYCLES	Figu	ire 4	Two vs Th	ree Pair	

INTERACTIVE INPUT UTILITY

by Mike Dougherty Littleton, Colorado

> You Can Improve the Usefulness of Your FORTH Programs by Adding this interactive input Utility

Introduction

FORTH contains a rich vocabulary to output data and information. Words such as .R, #, TYPE and .'' allow great flexibility for printing data. Unfortunately, user input is handled primarily through the text interpreter. Turnkey applications and users not familiar with FORTH often require a START consol switch is pressed, more interactive approach. The Input Utility, Listing 1, defines MENU and PROMPT to supply some of this missing interaction.

Menu

The utility MENU, Screens 55-67, allows a FORTH application to display lines 1-15 of a disk Screen as a menu of choices. A choice is selected from the menu via the keyboard consol switches. Line 0 of the menu Screen is reserved for MENU parameters. The entire menu Screen may be created or modified with a FORTH text editor.

A simple menu, Screen # 26, is shown in Figure 1. To use this Sereen as a menu, execute:

26 MENU

Upon execution, the current menu selection will be set to the first menu

selection. Each non-blank character in the eurrent menu selection is highlighted by inverse video. The Atari operating system shadow register, CHACTL, located at memory address 755, is used to blink the highlighted characters by the word BLINK. The user changes the current menu selection by pressing the SELECT or OPTION consol switch. When the

MENU returns the value of the current menu selection, 1 to n, where n is the total number of menu selections.

MENU uses two single precision numbers located in an ASCII free text format in line 0 of the menu Screen. The first number, TOP-MENU, defines the menu Screen line number [1 through 15] of the first menu selection. The second number, BOT-MENU, defines the menu Screen line number

```
SCR # 26
  0
  1
         **********
  2
  3
           GRADES SELECTION *
  4
  5
  6
  7
      SELECT one of the following:
 8
 9
        1) Read Class from Disk
 10
        2) Class Modification
 11
        3) Report Generation
 12
        4) Write Class to Disk
 13
 14
 15 Press START to choose SELECTion
    Figure 1
            Simple Menu
```

(TOP-MENU through 15) of the last selection. The total number of menu selections is BOT-MENU - TOP-MENU + 1 . These selection limits are read from the menu Screen by the word SET-LIMITS. MENU makes the assumption that each menu selection will take only one video line to display. When I use MENU, I set the left margin offset, LEFT-OFFSET, to 2 and limit each menu selection to a 32 character line. (My FORTH Screen Editor manipulates half lines of 32 characters with particular ease. For vertical spacing, the top margin offset, TOP-OFFSET, is set to 2. Extensions to MENU could allow the spacing offsets to be read from the first menu Screen line along with the selection parameters.

MENU relieves the FORTH application of the details of displaying text menus. Instead, the application is only concerned with responding to the user selection. Further, the menu wording may be modified without re-LOADing the application.

Prompt

The utility PROMPT, Screens 68-72, allows a FORTH application to prompt a user to input a single precision integer

within a specified range. The prompt is repeated until a value within that range is entered. APX fig-FORTH 1.1 already defines the word PROMPT to print the FORTH ''ok'' message. Since I never need this function, I let my utility redefine PROMPT. For any user requiring the old definition of PROMPT, the Input Utility version should be renamed.

The prompt text is created with the "defining word, Screens 68 and 69. For example, to prompt for examination grades, a prompt named TEST may be defined:

1 100 '' TEST Exam Grade (1-100): ''

The "defining word will use the next word in the input stream, TEST, to create a dictionary entry by the BUILDS portion of the "definition. The rest of the BUILDS compiles the input limits from the stack and a dimensioned string of characters into the dictionary. The results of the above PROMPT string is illustrated in Figure 2. Subsequent execution of TEST leaves the prompt text address, prompt length, minimum and maximum on the stack as defined by the DOES portion of the "defining word.

The following uses TEST as a prompt and returns a value in the range of 1 to 100 inclusively.

TEST PROMPT

The returned value will be a single precision number on top of the data stack. PROMPT will not return until a user number is entered within the specified range of 1 to 100. In general, to define and use the prompt XYZ to input a number between n1 and n2:

n1 n2 '' XYZ ... prompt text ...''
XYZ PROMPT

The use of PROMPT relieves the FORTH application of the burden of performing range validation for each input.

Conclusion

The utilities MENU and PROMPT were defined to solve specific problems. I had with my applications. Obviously, they can be modified to fit each user's own needs. The main idea remains to modify past FORTH definitions to fit into new situations, saving programming work and time.

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1133 BYTES)			menu:)		prompt:)					- FORCES A DISK READ IF NEEDED)	(Current menu number)	(line# —— addr) (Read and get address of line) (Drop the length of 64)			NEXT NUMBER)	(addr — addr n)	(Clear dest for dim string)	<pre>(Find numerical string limits) (Save the next string offset)</pre>	(Save length in dim string)	(Save a copy of the orig addr)	(Addr to move the string)	(Move dim string to HERE)	<pre>(Address of next string) (Convert to single prec num)</pre>	
SCR # 54 Ø (INPUT UTILITY	1 2 (To Load the utility: 3 (54 LOAD	5 (Usage:	- <u>-</u>	8 (26 MENU 9 (<pre>11 (min max 12 (" XYZprompt text"</pre>		15 —>		SCR # 55 Ø (ADDR OF LINE OF MENU - FORCES	1 2 26 VARIABLE MENU# 3	4 : ADDR-MENU 5 MENU# @ (LINE) 6 DROP :	^		SCR # 56 Ø (SCAN ASCII STRING FOR NEXT NUMBER)	1 2 : SCAN-NUMBER		4 BL ENCLOSE 5 > R		7 ROT > R R 8 ROT +	HERI	CMOVE	12 HERE NUMBER DROP ;	13
		***************************************	* Create TEST Prompt: * *	* 1 100 " TEST Exam Grade (1-100); " *	***************************************		Points to Previously Defined FORTH Word	4 + + + + + + + + + + + + + + + + + + +	of DOESY	Points to the FORTH Words after DDES> in the " Defining Word	Minimum Value for Prompt Input	Maximum Value for Prompt Input	<-Start of Prompt Dimensioned String Length of Prompt Text	Prompt Text										Dictionary Memory of TEST Prompt

```
Then blink the inverse chars )
                                                                                                                                                                                                                                                                                                                                                                                                                  Get the consol H/W register )
                                                                                                                                                                                                                                                                                                                   ( Wait until SOLID-BIT a zero )
                                                                                                                                                                                                                                                                                                                                                                                                                                Convert to positive logic )
                                                                                                                 ( Turn off the inverse chars )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ( Return the switch value now )
                                (OS shadow reg for display)
                                                                                                                                                                                                                                                                                                                                                                                                     Blink inverse if needed )
                                                                                                                                                                         ( Turn on the inverse chars )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Wait until switch released )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ( Wait until switch pressed )
                                                                                                                                                                                                                                                                             .INK ( - ) ( - ) RTC @ SOLID-BIT 6 AND IF ( If SOLID-BIT 1s a one )
                                                                                                                                                                                                                                                 Ø ( TIMING FOR INVERSE BLINK, READ THE CONSOL SWITCH )
                                                                                                                                                                                                                                                                                                                                                                                        - consol )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            - switch# )
                                                                                                                                                                                                                                                                                                                               RTC @ SOLID-BIT @ AND
                                                                                                                                             RTC @ BLINK-BIT @ AND
      Ø ( INVERSE CHARACTER BLINK )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Ø ( SAMPLE THE CONSOL KEYS )
                                                           8 VARIABLE SOLID-BIT 4 VARIABLE BLINK-BIT
                               2 755 CONSTANT CHACTL
3 2Ø CONSTANT RTC
                                                                                                                                                                                                                                                                                                       BLINK-INVERSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      GET-CONSOL Ø=
                                                                                                                                                                       2 CHACTL C!;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         GET-CONSOL;
                                                                                                    BLINK-INVERSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               GET-CONSOL
                                                                                                                  3 CHACTL CI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        2 : READ—CONSOL

3 BEGIN

4 GET—CONSC

5 UNTIL

6 BEGIN

7 GET—CONSC

8 UNTIL

9 GET—CONSOL
                                                                                                                                                                                                                                                                                                                                               Ø= UNTIL
                                                                                                                                                                                                                                                                                                                                                                                                                  53279 C@
                                                                                                                                                                                                                                                                                                                    BEGIN
                                                                                                                                                                                                                                                                                                                                                                                       : GET-CONSOL
                                                                                                                                                                                                                                                                                                                                                                                                                              7 XOR ;
                                                                                                                                                                                                                                                                                                                                                             ENDIF;
                                                                                                                              BEGIN
                                                                                                                                                                                                                                                                                                                                                                                                      BLINK
                                                                                                                                                                                                                                                                          2 : BLINK

3 RTC 6

4 BLI

5 BEC

6 F

7 Ø=

8 ENDI

9 GET-C01

11 BLINI

12 5327

13 7 X0]

14
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  SCR # 62
                                                                                                                                                                                                                                     SCR # 61
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  1
                                                                          Spaces from the left of video)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Save the current menu number )
                                                                                                            The top line of the options
                                                                                                                                        SCAN-NUMBER BOT-MENU ! ( The bottom line of the opts )
                                                                                               Read menu line Ø, get addr )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Get the address of the line
                                                                                                                                                                                                                                                                             Output SHFT CLEAR key code )
                             Screen line# of 1st choice
Screen line# of last choice
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Lines from the display top )
                                                                                                                                                                                                                                                                                                                                   Output n carriage returns )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Set the menu limit params )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                For each line in the menu )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Trim the trailing blanks )
                                                       Screen line# of current )
                                                                                                                            Sae for current line # )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ( Lines from top of video )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Erase the video screen )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       LEFT-OFFSET @ SPACES TYPE ( Output for user )
                                                                                                                                                                                                                                                                                                                      If more than Ø CR s )
Ø ( INPUT SELECTION LIMITS FROM MENU'S FIRST LINE )
                                                                                                                                                       ( Drop the final addr )
                                                                                                                                                                                                                                    Ø ( SCREEN DISPLAY FUNCTIONS )
                                                                                                             SCAN-NUMBER TOP-MENU 1(
                                                                                                                            TOP-MENU @ LINE# :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    2 2 VARIABLE TOP-OFFSET
3 2 VARIABLE LEFT-OFFSET
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TOP-OFFSET @ CRS
                                        Ø VARIABLE BOT-MENU
                            Ø VARIABLE TOP-MENU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           64 -TRAILING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              I ADDR-MENU
                                                       Ø VARIABLE LINE#
                                                                                                                                                                                                                                                                                                                                                                                                                                                         Ø ( DISPLAY MENU )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CLEAR-SCREEN
                                                                                               Ø ADDR-MENU
                                                                                                                                                                                                                                                             SET-LIMITS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DISPLAY-MENU
                                                                                   SET-LIMITS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           MENU# :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   16 1 DO
```

```
Update the line to highlight )
                                                                                                                                                                                                                                                                                                                                            The SELECT/OPTION sw pressed )
                                                                                                                                                                                                                                                                                                                                                                                                                             LINE# @ TOP-MENU @ - 1; ( Return 1-n based on inverse )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Save the current cursor mode )
                                                                                                  Back to the top of the menu )
                                                                                                                                          ( Invert the new current line )
                                           Invert current back to norm )
                                                                        ( If beyond the menu bottom )
                                                                                                                                                                                                                                                                                                     If a consol switch pressed )
                                                                                                                                                                                                                                                                         Highlight the first option) Walt until START consol )
                                                                                                                                                                                                                                                                                                                                                                        Flag the loop to continue )
                                                                                                                                                                                                                                                                                                                                                           CHANGE-SELECTION (Change the user selection )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Inhibit the screen cursor )
                                                                                                                                                                                                                                                                                                                                                                                                                 ( Loop until START pressed )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Get the user's selection )
                                                                                     Drop out of range value )
                                                                                                                                                                                                                                                                                                                               Flag exit from the loop )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Restore the cursor mode )
                                                                                                                             Set LINE# to new value )
                                                                                                                                                                                                                                                                                                                If the switch is START )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   menu# --- option# )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Display the menu )
                                                                                                                                                                                                                                                            ( u |
  Ø ( UPDATE A NEW USER SELECTION )
                                                                                                                                                                                                                              Ø ( MENU SELECTION FUNCTION )
                                                                                                                                                                                                                                                                                                  READ-CONSOL DUP IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Ø ( GENERAL MENU DRIVER )
                                                                       DUP BOT-MENU @ >
                1
2 : CHANGE-SELECTION
3 INVERT-VIDEO
4 LINE# @ 1+
5 DUP BOT-MENU @ >
C DROP
7 TOP-MENU @
8 ENDIF
9 LINE# !
1Ø INVERT-VIDEO ;
11
2 -->
                                                                                                                                                                                                                                           GET-SELECTION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SWAP 752 C!;
                                                                                                                                                                                                                                                                         INVERT-VIDEO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DISPLAY-MENU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 752 C@ SWAP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    SCR # 66
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Update the line to highlight
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Invert the new current line )
                                                                                                                                                                                                                                                                                        Do between line addr limits )
                                                                                                                                                                                                                                                                                                                    If not a video screen blank )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Back to the top of the menu )
                                           Get the hi mem page number )
Convert to address )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Invert current back to norm )
                                                                                                                                                                                                                                 Get starting addr of video )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ( If beyond the menu bottom )
                                                                                                                                                                                                                                                                                                     Get a byte from the screen
                                                                                                                                                                                                                                                                                                                                                 Restore the inverted char )
                                                                                                                                                                                                                                               Get the relative line # )
                                                                        Beginning of graphics Ø )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Drop out of range value )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Set LINE# to new value )
                                                                                                                                                                                                                                                                                                                                  Flip the video bit )
                                                                                                                                                                                                                                                                           40 bytes per line )
                                                                                                                                                                                                                                                              Adust for offset )
Ø ( GENERATE THE DISPLAY SCREEN ADDRESS )
                                - addr )
                                                                                                                                                                                                                                                                                                                                                                                                                                                  SCR # 65
Ø ( UPDATE A NEW USER SELECTION )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DUP BOT-MENU @ >
                                                                                                                                                                                                                                                                                          40 OVER + SWAP DO
                                                                                                                                                                            SCR # 64
Ø ( SCREEN FUNCTIONS )
                                                                                                                                                                                                                                                              TOP-OFFSET @ +
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        INVERT-VIDEO ;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CHANGE-SELECTION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          INVERT-VIDEO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                TOP-MENU @
                                                                                                                                                                                                     1

2 : INVERT-VIDEO

3 SCREEN

4 LINE# @ 1 --

5 TOP-OFFSET @

6 40 * +

7 40 OVER + SI

8 I C@

-DUP IF

10 128 XOR

11 I C!

12 ENDIF

13 LOOP; --
                                                                                                                                                                                                                                                LINE# 0 1 -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     LINE# @ 1+
                                           106 C@
                                                                       : - 1996
                                                        256 *
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ENDIF
```

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Convert next numerical string)
                                                                                             If not the end of line, null)
                                                                                                                                                                                                                                                                                                                                                                                                         Repeat until input in range )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          FORTH LinearTable Interpolation, FORTH Disk Source Utility. His
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             guest editorial' was featured in last month's issue. He has worked in
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Drop copies of addr, length )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Mike Dougherty has written a number of FORTH utilities that
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            the software field since 1977 and is currently a Software Engineer with
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         have/will appear in MICRO, including Structure Trees in FORTH,
                                                                               For each of the m numbers )
                                                                                                                                                                                                                                                                                                                                                            addr length min max --- n )
                                                                                                                                                                                                                                                                                                                                                                                                                          Start with a clean screen )
Ø ( INPUT A SET OF NUMBERS FROM A SINGLE LINE OF INPUT )
                                                Input the user text line )
                                                                Address of ASCII string )
                                                                                                                                               Deault to a zero value )
                                                                                                                                                                                                                                                                                                                                                                           Save limits for ?RANGE )
                                                                                                                                                                                                                                                                                                                                                                                                                                                         Get a single number )
Lop until in range )
                                 m --- n1 n2 ... nm )
                                                                                                                              ASCII text used up )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Clan up results )
                                                                                                                                                                                                                                                                                                                                                                                                                                           Show the prompt )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Martin Marietta Denver Aerospace in Colorado.
                                                                                                                                                                                                                                                                                                                          Ø ( PROMPT USER FOR INPUT )
                                                                                                                                                                                                                                                                                                                                                                                                                                                          1 INPUT-NUMBER
                                                                                                              SCAN-NUMBER
                                                                                                                                                                                                                                                                                                                                                                                                                         CLEAR-SCREEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CLEAR-SCREEN;
                                               PAD 80 EXPECT
                                                                                                                                                                                                                                                                                                                                                                           PROMPT-MAX :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        PRANGE UNTIL
                                                                                                                                                                                                                                                                                                                                                                                          PROMPT-MIN !
                                                                                             DUP C@ IF
                                                                                                                                                                                                                                                                                                                                                                                                                                           2DUP TYPE
                                 : INPUT-NUMBER
                                                                           SWAP Ø DO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       SWAP DROP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          SWAP DROP
                                                                                                                                                               ENDIF
                                                                                                                                                                              SWAP
                                                                                                                                               Ø
                                                                                                                                                                                                              DROP ;
                                                                                                                                                                                                                                                                                                                                                                                                           BEGIN
                                                                                                                                                                                             LOOP
                                                                                                                                                                                                                                                                                                                                                           : PROMPT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ŝ
                 1222116987677115115
                                                                                                                                                                                                                                                                                                                                                                                                           Ø ( CREATE PROMPT DEFINING WORD: min max "name string...text")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DUP PROMPT-MAX @ 1+ < IF ( Ifn is maximum or below ) DUP PROMPT-MIN @ 1 - > IF ( If n is minimum or above )
                                                                                                                                                                                                                                                                                                                                                                                                                                                         (Stack limits in min, max order)
                                                                                                                                                                            For each character in string )
                                              Compile name into dictionary )
                                                                                                                                                                                                                                                                                                                                                                                         Get the prompt minimum, save )
Get the prompt maximum, save )
                                                                                                               Save the next string offset
                                                                                            Find string numerical limits
                                                                                                                                                            Start of non-blank string )
                                                                                                                                                                                                                                                                                                                                                                                                                         Get the dim string length )
                                                             Compile min, max into dict )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               n is below minimum )
                                                                                                                            Copile length into dict )
                                                                                                                                                                                             Compile into dictionary )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               n is above maximum
                                                                                                                                             Save length of prompt )
                                                                                                                                                                                                                                                                                                                                         ( Set system TIB offset )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Set flag to true )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Set flag to false
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Set flag to false
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ( Minimum value allowed ) ( Maximum value allowed )
                                                                                                                                                                                                                                                                                                                                                                                                                                          Point to prompt text )
                                                                               Addr of string text )
                                                                                                                                                                                                             Next char address )
                              Define a prompt )
                                                                                                                                                                                                                                                                                                                                                                         - addr length )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                (n-1)
                                                                                                                                                                                                                                                                                           Ø ( CREATE STRING DEFINING WORD, CONT'D )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Ø ( TEST RANGE OF INPUT VALUE )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                2 Ø VARIABLE PROMPT-MIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              3 Ø VARIABLE PROMPT-MAX
                                                                                             ASCII " ENCLOSE
                                                                                                                                                                                                                                                                                                                                                                                         DUP @ >R2+
                                                                                                                                                                                                                                                                                                                                                                                                                                       SWAP 1+ SWAP R> R> R> SWAP;
                                                                                                                            OVER - DUP C, > R
                                                                           TIB @ IN @ +
                                                                                                                                                                                           DUP C@ C,
                                                                                                                                                                                                                                                                                                                                        R> IN +!
                                                                                                                                                                          R> Ø DO
                                                                SWAP , ,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DROP Ø
                                                                                                                                                                                                                                                                                                                                                                                                                         DUP C@
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DROP Ø
                                               < BUILDS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ENDIF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ENDIF ;
                                                                                                                                                                                                                           LOOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ELSE
                                                                                                               <u>۔</u>
۸
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            5 : ?RANGE

6 DUP PR

7 DUP

8 1

9 ELSI

10 DI

11 END

12 ELSE

13 DRC

14 ENDIF

15 -->
                                                                                                                                                                                                                                                                                                                                                                           DOES>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                SCR # 70
                                                                                                                                                                                                                                                                            SCR # 69
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Database Management Systems

by Sanjiva K. Nath San Francisco, California



Introduction

Computers are able to process data at incredible speeds. They can also store vast amounts of information in storage media a miniscule fraction of the size of filing cabinets. We refer, of course, to disks, cassettes and diskettes. Computers can organize information, sort it and present it to you in any order that you specify, all at a fraction of the time that you would take to do the task manally. Consider, for example, sorting through a list of about 1000 addresses to extract a few corresponding to a specific ZIP code, or searching through a library card catalog for books authored by Joe Smith on the subject of mating rituals of blue whales. Either of these tasks performed manually would require, even by the best estimates, at least a few days. But a computer can accomplish that in minutes. You can easily understand, therefore, why one of the most common applications of computers is information management.

Information Management or Database Management

Computer-assisted information management begins with organizing data in the form of records. A record is the fundamental unit of a large structure called a database. It contains information relating to one subject. For example, in a library card catalog, each 3x5 index card contains information

relating to the bibliography of a book. Each card is, therefore, a record. A collection of related records may be grouped into a file. For example, a collection of employee records constitutes a personnel file. And a list of patients, with their medical history and insurance details, may form a patient file.

From Records to Databases

You can further group files containing related information and create a database. A simple database may only consist of one file. For example, a list of your friends with whom you frequently correspond, their phone numbers, and mailing addresses is such a database. A more complex database, on the other hand, consists of information contained in many files. These databases provide information on a wide variety of subjects to a larger audience. They also facilitate communications between many users for on-line conferences. One such database, CompuServe, provides information on many areas of interest such as science, education, games, programming, etc. It also lets you talk to other computer users and hold conferences within your computer club, over the telephone line using your computer and a modem. You can also shop through their special on-line "vendor service".

Another database popular with investors, is the Dow Jones News and

Information Service that provides stock quotes (current and historical), profiles on public corporations and latebreaking news that may affect the performance of stocks. These databases, due to their size and complexity, are handled by more powerful mainframe computers.

Due to the organization and large capacities of databases, many businesses use them to store any information pertaining to their business operations, such as employee payroll files, accounting records, customer files, etc.

A database, therefore, is the next logical step to files in the hierarchy of information organization. It is an organization of a large number of files that may have some inter-related data. A small business, for example, may have a database consisting of personnel files, inventory files, and customer files. As you see, these files are not related to each other. However, they contain information that belongs to one company. In order to access records in any one of these files, you access the database instead of individual files. The database program will, in turn, call the appropriate file in memory and extract the data requested. This type of file organization benefits users handling a large number of files containing related data. Ordinarily, in order to access any information in these files, you either have to remember the file that contains the specific data or worse, search through

the files one at a time. A database will not only provide you access to that particular file, but also other files that may contain related information. All you have to do is specify certain keywords and cross references recognized by the database.

Applications of Database Management

We have mentioned the advantages of computers in handling large amounts of information and their applications in database management, especially for large businesses and organizations in both government and private sectors. However, our primary interest in understanding the principles of database management is its immediate applications in our lives. To that end, we devote the rest of the article to implementation of database management systems (DBMS) on microcomputers such as the Commodore 64.

Before microcomputers became widely available, our record-keeping systems commonly consisted of either a stack of 3x5 index cards or a cabinet full of file folders. Each card or file contained information about one of a group of similar items {a magazine article perhaps, or a customer with whom you correspond} and was filed in ascending numerical or alphabetical order.

There are several limitations to such a filing system. First, the retrieval of specific records from, say, an index card file, can only be made at one level; that is, if the cards containing a mailing list are arranged in alphabetic order by the client's last name, then you can only access them by last name. If you wish to access selected cards by a specific city or zip code, you will have to search the whole card file. This also makes record updating very tedious. Another disadvantage is obvious: you can not, through such a filing system, print out a list of all, or selected, records

The card index files are most popular in libraries. They get around some of the above limitations by maintaining three index files for each publication (subject, author and title) and using lots of cheap labor (students).

The availability of Database Management Systems (DBMS) on microcomputers has made possible the storing of a wide variety of information on floppy diskettes, thus eliminating the need for 3x5 card files, large filing cabinets and hours of labor. Information in these files may be indexed in many ways, all of them defined by you. Furthermore, you may quickly select and retrieve any records from file at any time. You may also print records in a report format. The fact that these records are maintained on disk files also makes them much faster and easier to update than a card index file. Some sophisticated programs also allow the merging of records with text files. This feature is especially useful for creating personalized form letters; you can merge a standard letter with many addresses and the computer will automatically print out letters, each with the appropriate address. A calculator function, available in a few programs, even allows you to perform arithmetic and logical operations on records containing numeric data.

The applications of database management systems extend much further than the examples cited above. You may store any type of information that you want by creating your own fields (see definition below). The program will let you search through that information, sort it in any order and generate a list of any or all records in that database. For example, let us assume that you have created a database of your customer accounts in the United States. You can now generate a list of your most valued accounts in the entire U.S., or all accounts in a specific area.

Another DBMS special feature mentioned above is the calculator function. Using this feature, you may perform calculations on parts of your records. This is helpful when you wish to update balance owing in your customer accounts. The calculations may be performed on all or selected records.

In addition to maintaining customer accounts and mailing lists, DBMS are also used for other applications such as stock records, inventories, contract records, student records, sales ledgers, invoices, personnel records, etc.

In the next section, we will suggest some important factors to be considered when you select a database management program for your Commodore 64. We will also provide brief reviews of 15 DBMS programs currently available for the C-64.

There are many factors that you might consider, when selecting a particular DBMS for yourself. The most important is its application. Many programs are available, at prices starting at \$25-\$30, and going to \$150 and above. Some of these are general purpose programs, whereas others are specifically designed for one application. A mailing list, for example, is a DBMS designed to maintain a list of names and addresses. Similarly, there are DBMS designed to aid teachers in keeping track of student grades and attendance. If you only need a DBMS program to maintain, for instance, a relatively simple mailing list or inventory file, then the price vs performance ratio may be an important consideration. If, however, you need some sophisticated features in a DBMS, then an advanced DMBS system costing \$100 to \$150 may be a good investment. In order to help you evaluate these programs, with respect to your applications, we will present a list of criteria that will prove to be useful. These criteria may be used to compare the available programs to determine the price vs performance ratio of each, and perhaps select the one that is the best buy. These criteria are as follows:

Start-Up Options: When you first load and execute a DBMS program, it offers [via the main menu] a variety of options. Using these options, you may configure the system peripherals from within the program. These options may involve printer set-up, DOS commands, screen background/text color changes, etc.

Printer set-up, for example, will let you set up the program for the particular printer that you have (NEC, Diablo, Spinwriter or Centronics-type parallel).

DOS commands refers to accessing the functions and commands of the disk operating system from within the program. This enables you to format a diskette or obtain the disk directory without exiting the program.

Changing screen background/text colors is useful for getting the best contrast between the background screen and the text for improved readability. Although there are up to 256 color combinations available on the Commodore 64 [sixteen background and sixteen text colors], only a few allow optimum readability.

File Structure and Specifications: The efficiency of a particular DBMS in storing and retrieving data from a file depends primarily upon the file structure used. Relative files and random access files provide the fastest data storage and retrieval. Relative files have the added advantage that the record length may be altered. Records that are stored in sequential files, however, are only accessible in the order in which they are stored, so the last record entered into the file will be the last record accessed. In order to implement DBMS functions such as sorts and searches in sequential files, the data has to be loaded into memory completely. This restricts the size of the file (due to limited memory available in the computer) and makes it less versatile. Updating sequential file records is very time-consuming and tedious. Most good quality DBMS, therefore, use relative or random access files to handle record storage.

Specifications refers to the limitations a program imposes on the file and record structures you can create. For example, a program may allow a maximum of twenty-five fields per record and thirty characters per field in each record. If you wanted to use that program to record a mailing list of customers, these specifications may be sufficient. But if you want to store abstracts of magazine articles. you may not have enough space. If you have a specific application in mind, you will find it easier to choose a particular database management system. Otherwise, the more versatile a particular program is, usually, the more favorable it will be with respect to general applicability.

Advanced Data Handling: This refers to features such as "sorts" and "searches" that are available in most programs. The sort feature allows you to arrange the records in your database in a number of ways. You can sort a file in either alphabetic or numeric order. You may use one or more fields to sort your data. For example, if your database consists of mailing addresses, by using the advanced sort feature you may arrange that list in an alphabetical order by customer's last name or by city. You may also want to rearrange the same list in numeric order by the zip code. The search feature lets you look into your data base for specific records. You can define the criteria by

using "conditional" statements (such as IF Last Name = Smith OR City = New York) and the program will automatically search for records that match the criteria defined in the conditional statements. Sorts and searches may be performed at one or multiple levels.

Another feature available in most advanced DBMS is the ability to set up calculated fields in your database. This allows you to perform mathematical operations on specified fields of your database file [such as adding tax to the price of a stock item or averaging student grades]. In many cases, you can use BASIC's mathematical operators for your formulas for the calculated fields.

Report Generator: A useful function of a DBMS is its ability to generate userdefined reports which may contain a few or all of the records in the file. The reports may be organized as a table or a listing, and the fields may be positioned anywhere on the paper. This flexibility in defining the report format makes a program versatile in its applicability. You can print mailing labels or get a simple listing of a few names and addresses. You can also print selected fields from each record to form a comparison chart. A good database system will support many different types of printer configurations and print formats.

Special Features: In this category, we have included the various features of a program that either add to its performance and applicability or make it outstanding in comparison with other similar programs. For example, a DBMS might feature an integrated word processor and a programmable calculator. This particular package may be of great value if you plan to use your DBMS for creating personalized form letters or keeping track of inventories. Another system may be designed for storing bibliographies. Its use is therefore limited to a specific application.

Glossary

The following terms are most frequently encountered in the manuals of database programs:

Add Fields: Suppose you have ereated a database of names and addresses of all

your employees. Now you want to add another field (date of birth or starting date on the job) to this file. Some programs will not allow you to add a field to the pre-existing file. In this case you will have to start all over again, create a new file and enter all the records. The ability to add fields to a file is a useful feature that very few programs offer. With most DBMS, you must design the file structure very carefully, since you may not be able to add more fields to your file.

Browse: This feature, available in most database management systems, allows you to look at the records in a file sequentially, starting with the first one. This 'browsing' may also be performed in a reverse order (i.e., if you are currently working with the 100th record and you want to view the preceding few records, then you may browse in a descending order).

Calculator: This is a useful feature in a database management system. It lets you perform arithmetic calculations on the numeric data types in your records. The types of calculations that you can perform vary from program to program. The feature, however, adds to the versatility of the DBMS in its applications.

Conditional Statement:

statement consists of logical operators (such as IF, THEN, GE, LE, EQ) that may be used to select specific records from a database. For example, you may use a statement like, "IF last name EQ Smith AND City EQ San Francisco," to tell the computer to select only records which have "Smith" in the last name field and "San Francisco" in the city field.

This

Database: A database is a collection of information organized in the form of records. It may be a list of customers' phones and addresses or an inventory of items in stock. The term database is also commonly used in relation to large information networks such as the Source or the Dow Jones News Retrieval service.

Database Management System: Often abbreviated DBMS; refers to a collection of computer programs that facilitate the creation and use of a database in the form of a file|s|. It is an electronic filing system that offers efficiency in data storage and retrieval.

Editing: Once you have entered your records in a file and want to update a specific record or you entered some information incorrectly and want to correct it, you will be working in the editing mode of a DBMS. The manner in which this mode is implemented in each program and the efficiency with which your are able to update your records is considered here.

Field: A field is a specific data type. This may be the book title in a library card catalog, or a zip code in a mailing list. A record consists of many interrelated fields. Information within a field may or may not be identical between records. For example, in a file containing a mailing list, each record might contain five fields: name, street, city, state and zip code of clients. If two clients live in the same block, their zip code will be the same: therefore, the information in those fields will be identical in the respective records. Fields may be used to perform sorts and searches within a file, although some DBMS will search only on key fields.

File: A collection of records on disk that are saved under a unique name. The records consist of identical data types (fields). For example, you may have a file containing a list of vendors that manufacture software for the Commodore 64. All records in this file will have identical field structure (i.e., all records will contain the name and address of the vendor and the product that they manufacture).

Function Keys: The Commodore 64 has four undefined, programmable keys on the right side of the keyboard. These keys are often referred to as the function keys. By using these keys in conjunction with the shift key, you can actually perform up to 8 functions in your program. The function keys add to the ease and efficiency of using the features of a certain program. For example, you can use the function keys to select various menu options of a program. Without them, you would normally have to physically type in each option.

Help Screen: Some programs display a list of commands and functions to help you select the right command for a specific function. This way, you are not forced to memorize all the commands of the system and their specific functions. This is referred to as a help screen.

Key: A key is an identifier consisting of one or more fields. It is used to sort, search and format output of desired data elements. If you have a database of sales records, for example, then you may identify one or more fields (salesman, product name, etc) in this database as key fields. This will enable you to sort or search the entire database for specific records by establishing criteria using these key fields. Some DBMS will allow searches only on key fields, while others will search for non-key fields with a slower process.

Menu-Driven: Many DBMS packages display the master menu when the program is first executed. Selection of a function or option from the master menu results in the display of another menu that contains more detailed features of that particular function. Such a system or program is called menu-driven.

On Screen Prompts: These are the prompts that a program displays on the monitor screen every time it requires you to perform a certain task such as inserting a new disk or change printer paper, etc. These prompts are very helpful since they do not require you to memorize every step that you go through during the program execution. The program keeps you informed of the next step and any inputs that it needs from you.

Random Access File: A type of disk file that allows you to directly access records through the program by specifying the drive, track and sector number. These files are not given names and do not appear in the disk directory.

Record: A record is a collection of data items (fields). In a personnel file, for example, the information on each employee is considered a record. The maximum number of records that a database may contain is limited by the size of each record and available space on a diskette.

Relative Files: These are similar to random files, except that the files are given unique identifiers (file names) and the record length in the file is alterable. A relative file may contain up to 720 records.

Report: A report is a user-defined printout (or hard copy) of selected information in the database. Many

different kinds of reports may be generated by a DBMS such as lists, forms, tables, etc.

Search: This function allows you to search a file for specific records that you have defined with conditional statements.

Security: A feature available in some DBMS that allows you to restrict access to those with a password.

Sequential Files: A file that sequentially stores data on disk. Access to data is made in the same order each time (from the first element in the file to the last element in the file). This type of structure makes searches or record updating very time-consuming and tedious.

Sort: This is a function [available in some DBMS] that allows you to rearrange the records in your database alphabetically or numerically. You may also be able to select [using conditional statements] the records to be sorted instead of sorting the whole file.

Spreadsheet Features: Some DBMS have built-in features which allow you to build a spreadsheet from selected database records.

Start-Up Options: These are the options available to you through the program when you first load and execute it. The options are displayed through the main menu. They may include printer set-up, disk initialization, color adjustment, etc.

Word Processor Interfacing: Some DBMS allow you to create a file from the database which can be further processed by a word processor.

Next Month

Part II of this article will deal with specific database management systems available for the Commodore 64.

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BASIC/ML Data Transfer

by Mark 'Jay' Johanson Germantown, Ohlo

A Number of Techniques are Presented to Transfer Data Between BASIC Programs and Machine Language Subroutines

While writing programs using a BASIC interpreter is very easy and convenient (or at least, easier and more convenient than most other methods), I am sure that I am not alone in the discovery that BASIC programs sometimes run extremely slow. The obvious alternative is to use machine language, but writing in machine language, even with the aid of an assembler, is significantly more difficult than writing in BASIC; sometimes it can become overwhelming.

A common solution to this dilemma is to write machine-language subroutines into your BASIC program, using BASIC for the bulk of the program because of its convenience, but using machine language for a few critical routines for the sake of speed, choosing routines for which ML will give significant performance improvements. While such a scheme can be very effective, there are several problems (opportunities?) which must be overcome. It is my purpose here to address one particular problem involved in such programs: transferring data between the two languages, specifically on the Commodore Vic-20 and 64. While users of other machines may be able to make use of some of the basic principles that I will discuss here, many of the details are, unfortunately, tied to the workings of Commodore's BASIC interpreter and operating system.

In the discussion which follows I assume that the reader has some knowledge of 6502 machine language. As an aid to comprehension, in all my sample programs, I include the assembler equivalent of any machine language code as REMarks following the POKE values. As it is not my purpose here to discuss the question of where to locate an ML routine in memory, in these examples I will simply put my ML routines (and data) in the cassette buffer.

POKEing Along

The most obvious way to make BASIC's data available to machine language is via the POKE statement and, likewise, data can be retrieved by BASIC with a PEEK function. If you have been using machine language routines you are probably familiar with this technique, so I will only discuss it briefly here.

In order to use this method, it is only necessary that you decide on some specific memory location which is to hold the data and then cause both languages to access it. Program 1 demonstrates this by reading in a number using BASIC, passing it to a machine language routine which adds two to it and then using BASIC again to print out the sum. (And before you point out that this is a totally inane use of machine language, let me hasten to add that it is by no means intended to be a useful program: it is just a demonstration.)

Remember that POKE values are limited to one byte, i.e. 0 thru 255. A Commodore BASIC integer is two bytes, so to allow for a full range of integer values we must use something more like Program 2. This begins to illustrate some of the problems with this method of transferring data: if we want to pass more than one byte things begin to get rather involved.

This method has the advantage of being straightforward and general, but as the amount of data to be passed becomes large, all the PEEKs and POKEs can become very tedious. Furthermore, the POKE is one of the slowest instructions on the Commodore, so if you have a lot of them, they can slow your program down.

Using USR

A second method of transferring data involves the USR function. This function is seldom used but can be very handy in certain situations. Before using it you must first POKE the address of the machine language routine into locations 1 and 2 on the Vic-20, locations 785 and 786 on the C-64, in the standard low-high format, i.e.

POKE 1, AD AND 255 POKE 2, INT(AD/256)

(for the Vic). It can then be used just like any other function, ranging from a simple A = USR(B) to including it within a complex expression and, just as for any other function, the value within the parentheses may itself be an expression.

When the function is used within a BASIC statement, control will be passed to your machine language routine in a manner similar to what happens when you use a SYS statement, and control will be returned to BASIC when your routine executes an RTS instruction (or more correctly, when it executes one more RTS instruction than it has JSR instructions. But when the ML routine begins, BASIC will have placed the value found within the parentheses (the result of the computation if this was an expression as a floating point number in locations 97 thru 101. When your routine finishes, it should place a floating-point value in this same location: this number will be used as the result of the function. For example, if you had the BASIC statement:

X = 2*USR(A/B + 2)-7

then, when your ML routine was called, the value in locations 97-101 would be the result of the computation A/B+2. If your routine deposited the number 5 into this location, then X would end up being assigned the value 2*5-7, or 3.

If you wish, you may work directly with these floating-point values. Unfortunately, floating-point numbers are very difficult to work with personally, aside from a couple of demonstration routines to prove to myself that I could do it, I have never used them. However, Commodore has graciously provided us with conversion routines: a floating-to-fixed routine at location 53674, and fixed-to-floating at 54161. Conveniently, both these routines use 97 thru 101 as the location for the floating-point number, the same location accessed by USR. They use the A and Y registers for the integer value, with the most significant byte in A and the least significant in Y. (According to the Vic 20 manual, they use memory locations 20 and 21 for the integer value. Unfortunately, this does not appear to be the case. Numbers do appear there whenever BASIC does an integer conversion, but these locations are not accessed by the routines mentioned above. Perhaps there is some other routine which moves values between A:Y and 20-21 but, as this is a relatively trivial operation, I have not bothered to look for such a routine within the operating system.

Thus, all the ML routine must do upon execution is execute the floating-to-fixed conversion with a JSR 53674, do whatever work it desires with the integer value which will now be in A:Y and then, when it is finished, put the desired return value in A:Y and execute the fixed-to-floating routine with a JSR 54161. This is demonstrated in Program 3 which, again, will simply add two to the entered number.

The major advantage of the USR function is that it makes your BASIC program simpler, faster and more readable. It is not necessary to do cumbersome PEEKs and POKEs to move the data around and the resultant value of the function can be used directly in a more complex formula without any intermediate steps. It does require two extra instructions in the ML routine - the JSR's to do the conversions — but this is a small penalty and, for that matter, these routines end up putting the value into registers, which you would probably have taken a couple of instructions to

do anyway. A bigger drawback is that you can only get one value into the function and if you want to use more than one USR routine in the same program you may end up having to continually alter which one is 'active' by POKEing values into the USR vector; that destroys the advantage of not having to do POKEs to get the data in. In short, don't try to use USR for every ML routine you ever write from now on; USR is only of value in certain limited situations. But when it is helpful, it can make your program much more elegant and slightly faster.

Make-Believe Registers

I stumbled upon a third method of transferring data between BASIC and ML almost by accident. I only recall seeing it used by someone else once, and in that instance the writer included it in a program without explanation.

In the memory maps found in the Vic-20 and C-64 manuals, for locations 780 thru 783 one finds the cryptic notes, 'storage for 6502 A register', 'storage for 6502 X register', etc. I found no further explanation in the manual of what these are for, so one day I became curious about them and tried some experimenting which led me to discover this useful fact: whenever you use a SYS statement in a BASIC program, before control is transferred to your routine the system loads the registers with the values found at locations 780-783; when your routine exits, before control is returned to BASIC the system stores the values of the registers at these locations.

At first glance, this feature may seem to be of only marginal value. Instead of saying POKE 828,N before calling your ML routine and then having the ML routine begin with a LDA 828, you could simply say POKE 780,N and then when your routine began the desired value would be waiting in the A register. So big deal, we've saved one instruction. A somewhat more useful application would be for an ML routine to leave data in the registers; the next time this routine is executed the registers will appear to have been unchanged by anything BASIC may have done in the meantime, because the system will have saved off the registers when it finished and then restored them with the same values when the routine was re-entered (assuming neither the BASIC program nor some other ML

routine had modified locations 780-783). Still, this would only save us from having to do some POKEs.

However, there is one situation where this feature can be quite useful, namely, when we want to use one of the kernal routines from within a BASIC program. This is best illustrated with an example. Commodore BASIC includes no cursor positioning command. Thus, if you want to plant the cursor at a specific location on the screen using BASIC, about the best you can do is something like Program 4, using 'home' followed by variable numbers of 'down's and 'right's to get the cursor to the desired location. This example creates a string with the maximum number of cursor movement keys you can use (on the Vic-20), and then does LEFT\$'s on them to get the desired number. For demonstration purposes, it simply asks for a row and column number, prints an asterisk at that location and then waits for any key to be struck to tell it to clear the screen and repeat the process (indefinitely).

But this is inefficient and inelegant. Hope appears when we note that the kernal does have a cursor positioning routine, beginning at location 65520. However, this expects the row and column to be in the X and Y registers respectively, and BASIC cannot directly modify the contents of the registers. (The BASIC interpreter is using the registers constantly while executing our BASIC program, so even if BASIC did include an instruction that modified a register, the inserted value would quickly be overwritten. Thus, it would appear that we are forced to pass the desired row and column to an ML routine which will actually load the registers and execute the call. An example of this is given as Program 5 which performs the same task as Program 4, but using the kernal plot routine instead of strings of cursor control characters. Note that, even though the ML routine is trivial, the program still has to go to a certain amount of trouble to load and execute it. Perhaps this is not a terribly heavy price, but there is a better way.

Program 6 uses the location 780-783 feature to call the kernal plot routine from BASIC without the need for any 'ML interface routine'. It performs the same function as Programs 4 and 5, but note that actually doing the plot takes only four statements: three POKE's and a SYS. (The third POKE is needed because the plot routine can actually perform two functions: planting the

cursor at a given location, or telling you where the cursor is currently sitting. It decides which function to perform depending on the contents of the carry flag, which we here set to zero by means of the third POKE. This will also set all the other flags to zero, but, as we don't care about their values, it's easiest to set them all to zero and avoid any possible confusion.)

As you can see, while it is unlikely that this facility would be of any help in passing data into your own routines, it can greatly simplify the use of routines from the kernal. By the way, note that all of this works with the SYS statement; it does not work with USR.

BASIC's Backyard

Someone might reasonably ask, "Why must we make a copy of the data to pass to an ML routine? Why not let the ML routine use BASIC's variables directly, in the same locations in which BASIC actually stores them for its own use?" This thought leads to a technique which is more complex than those I have discussed previously, but which is extremely efficient, especially when there is a great deal of data to be passed.

The obvious hurdle to be overcome here is finding where BASIC stores its variables. We could investigate where the variable table is located and how it is laid out and then develop a routine to find any desired variable, but this is not necessary. BASIC has to do that work itself all the time, so we can simply let it do this for us.

If you look at a memory map you will see that locations 71 and 72 are described as 'current variable address'. Using this clue I experimented a bit and discovered that these two bytes always contain the address of the last variable that you have used in your program. Thus, if you code a line such as N = 0: POKE 251, PEEK(71): POKE 252, PEEK (72), you will put the address of N into locations 25 I-252. (Note that if you entered N = 0: A1 = PEEK(71): A2 = PEEK(72) you would not end up with the address of N in A1 and A2, because by using two more variables you will have overlaid the previous address. You must avoid using any other variables until you have copied the address into a safe place. This essentially means that you must POKE it somewhere, as that's the only way (that I can think of) to move data without using a variable.) If you execute a statement such as this at the beginning of a BASIC program and stow

the variable address in some convenient location, an ML routine could refer to that variable from then on. For an elementary variable, it is not necessary to redo the look-up as Commodore's BASIC will never move a variable once it has been created (an array, however, may be moved).

The next issue to be considered is exactly what you will find at this address. This depends on the variable type. If it is a floating-point number, at the given address will be the five byte floating-point value. As I mentioned earlier, floating-point numbers are difficult to work with using machine language and so I will dispense with any further discussion of them here.

More useful are integer variables. For these the address is that of a two-byte integer, with the most significant byte stored first, followed by the least significant byte. Note that this is the reverse of the order normally used on the 6502. [I've forgotten this and slipped up several times.]

Program 7 uses this technique to perform the same dull 'add 2' operation. A few points are worth comment here. The most straightforward way to use the variable address is to store it somewhere on page zero and then use the (addr), Y addressing mode to access the data. For this example I have put it at locations 251 and 252, two of the four page zero locations which Commodore promises that BASIC will never disturb. Four bytes is only enough room to store two variable addresses permanently, so in real life you would probably have to store the address elsewhere and then move it to page zero when it is needed. This is demonstrated in Program 7B.

While the work that must be done in BASIC is no more involved than that required for any other method, the ML routine does need several extra instructions to find the variable. If your routine is short and only uses a few bytes of data, this extra work is probably not worth it. As your routine becomes larger a few extra instructions become less significant (as a percentage), and, if you must pass a lot of data back and forth, this technique lets the ML routine do all the work rather than BASIC, which is a much more efficient system.

Speaking of the amount of data to be passed, consider the following: An integer occupies two bytes and a floating-point number 5, but a string variable may take up to 255 bytes. To try to pass this much data to an ML

routine by copying it with POKEs would be extremely cumbersome; this is where you would save the most by working on the variable directly. Program 8 demonstrates this with a routine to examine a string and replace every occurrence of a dollar sign with a pound sign. (Which is about as useful as reading in a number and adding two to it.) For string variables, the address found in locations 71-72 points to a three byte area containing first a onebyte length value and then a two-byte address of the actual string. Thus we must follow two levels of indirection to get to the actual data; the first address points us to an area containing, not the data itself, but rather another address pointer to follow. Note that while the address of this three-byte area will never change during the execution of a program, the second address, the address of the string itself, will change everytime BASIC modifies the string. as well as on other occasions when BASIC does its 'garbage collection' to clean up unused areas in string space. So even if you don't modify the string, don't count on it staying put. Have the ML routine reload this second address every time it executes.

There is one caution to be borne in mind when modifying string variables in place; while you may freely change the contents of any byte in the string and you may make the string shorter by altering the length value, you should definitely avoid trying to make the string longer, as you probably have no idea what may happen to be sitting in the space following the present contents of the string. Usually this will be another string variable and you normally don't want to destroy other variables. While it is possible in principle to create a dummy variable from which you will take the needed space, you would have to be careful that the garbage collection routine did not get invoked at the wrong time and move your variables in relation to each other. I have found it far more practical to let BASIC either do all the lengthening (by concatenating strings together or to add a bunch of dummy characters to the end of the string so that the ML routine need only shorten it by the number of added bytes that it decides it doesn't need. For example, before executing the ML routine, use BASIC to add 10 spaces to the end of the string. If the ML routine then decides that six extra spaces were needed, it reduces the length by the difference, or four bytes.

I tend to prefer this 'in-place' method of data transfer because of its 'cleanness'; the BASIC program isn't cluttered up with a lot of POKEs, but simply sets variables just like it would before a GOSUB. But if only a couple of bytes of data are being passed, or if the ML routine is rather short, then the extra ML code required seems excessive.

Parting Thoughts

Each of the four methods of transferring

data which I have presented here has its own uses. The simple PEEK/POKE is good for small amounts of data and general 'quick-and-dirty' applications; USR is handy when you want an ML routine to produce a result which will be used in an expression, or when the input to it is the result of an expression; the register storage area is convenient for setting up calls to kernal routines; and working directly in BASIC's variable area is a help when there is a large amount of data to be passed, especially string variables.

I don't doubt that other techniques could be found with their own particular advantages. It's good to have a variety of techniques at your disposal - just because something works well in one situation, don't assume that that is all you'll ever need. A monkey wrench is a handy tool: it can be used on bolts of almost any size and in a pinch you can use it as a hammer or a crowbar. But the job will be a lot easier if you take something in your toolbox besides a monkey wrench.

```
1Ø3 DATA 141,61,3:REM STA 829
                                                              11Ø DATA 173,6Ø,3:REM LDA 828
O BML 1
                                                              12Ø DATA 24:REM CLC
     10 REM PROGRAM 1
0
     20 REM TRANSFER DATA WITH PEEKS AND POKES
     3Ø FOR AD=84Ø TO 849: READ B: POKE AD, B: NEXT
     110 DATA 173,60,3:REM LDA 828
     120 DATA 24:REM CLC
     130 DATA 105,2:REM ADC #2
     140 DATA 141,60,3:REM STA 828
     15Ø DATA 96:REM RTS
                                                              200 REM
     200 REM
     210 INPUT N
                                                              210 INPUT N
     22Ø POKE 828,N
                                                              22Ø N2=USR(N)
     23Ø SYS 84Ø
                                                              24Ø PRINT N2
0
     24Ø PRINT PEEK(828)
O BML 2
                                                           BML 4
0
      10 REM PROGRAM 2
      20 REM TRANSFER TWO BYTES WITH PEEKS AND POKES
      3Ø FOR AD=84Ø TO 857:READ B:POKE AD,B:NEXT
      110 DATA 173,60,3:REM LDA 828
0
      120 DATA 24:REM CLC
      130 DATA 105,2:REM ADC #2
      140 DATA 141,60,3:REM STA 828
0
      150 DATA 173,61,3:REM LDA 829
                                                              13Ø GOTO 1ØØ
      16Ø DATA 1Ø5,Ø:REM ADC #Ø
      170 DATA 141,61,3:REM STA 828
      19Ø DATA 96:REM RTS
0
      200 REM
                                                            BML 5
      21Ø INPUT N
      22Ø POKE 828, NAND255: POKE 829, INT(N/256)
0
      23Ø SYS 84Ø
      24Ø PRINT PEEK(828)+256*PEEK(829)
0
    BML 3
0
      10 REM PROGRAM 3
      20 REM TRANSFER DATA VIA USR FACILITY
0
      30 FOR AD=840 TO 875:READ B:POKE AD,B:NEXT
      1Ø1 DATA 32,17Ø,2Ø9:REM JSR FIXFL
      1Ø2 DATA 14Ø,6Ø,3:REM STY 828
```

```
130 DATA 105,2:REM ADC #2
14Ø DATA 141,6Ø,3:REM STA 828
150 DATA 173,61,3:REM LDA 829
16Ø DATA 1Ø5,Ø:REM ADC #Ø
17Ø DATA 141,61,3:REM STA 829
171 DATA 172,60,3:REM LDY 828
172 DATA 173,61,3:REM LDA 829
18Ø DATA 32,145,211:REM JSR FLFIX
19Ø DATA 96:REM RTS
205 POKE 1,72:POKE 2,3
10 REM PROGRAM 4
20 REM CURSOR POSITIOING WITH DOWN'S AND RIGHT'S
3Ø R$="{HOME, DOWN22}"
4ø C$="{RIGHT22}"
100 PRINT"{CLEAR}";:INPUT"ROW,COLUMN";R,C
11Ø PRINT LEFT$(R$,R); LEFT$(C$,C-1); "*";
12Ø GET I$:IF I$="" THEN 12Ø
10 REM PROGRAM 5
20 REM CURSOR POSITIOING WITH KERNAL PLOT ROUTINE
30 FOR AD=840T0850: READ B: POKE AD, B: NEXT
4Ø DATA 174,6Ø,3:REM LDX 828
50 DATA 172,61,3:REM LDY 829
6Ø DATA 24:REM CLC
7Ø DATA 32,24Ø,255:REM JSR PLOT
8Ø DATA 96:REM RTS
100 PRINT"{CLEAR}";:INPUT"ROW,COLUMN";R,C
11Ø POKE 828,R-1:POKE 829,C-1:SYS 84Ø:PRINT"*";
120 GET I$:IF I$="" THEN 120
13Ø GOTO 1ØØ
```

BML 6

10 REM PROGRAM 6

20 REM CURSOR POSITIOING WITH KERNAL PLOT ROUTINE AND NO ML INTERFACE

100 PRINT"{CLEAR}";:INPUT "ROW, COLUMN";R,C

11Ø POKE 781,R-1:POKE 782,C-1:POKE 783,Ø:

SYS 6552Ø:PRINT"*";

12Ø GET I\$:IF I\$="" THEN 12Ø

13Ø GOTO 1ØØ

BML 7

10 REM PROGRAM 7

20 REM TRANSFER DATA BY VARIABLE ADDRESS

3Ø FOR AD=84Ø TO 856: READ B: POKE AD, B: NEXT

40 DATA 160,1:REM LDY #1

5Ø DATA 24:REM CLC

6Ø DATA 177,251:REM LDA (251),Y

7Ø DATA 1Ø5,2:REM ADC #2

8Ø DATA 145,251:REM STA (251),Y

9Ø DATA 136:REM DEY

100 DATA 177,251:REM LDA (251),Y

11Ø DATA 105,0:REM ADC #Ø

120 DATA 145,251:REM STA (251),Y

13Ø DATA 96:REM RTS

200 REM GET ADDRESS

21Ø N%=Ø:POKE 251,PEEK(71):POKE 252,PEEK(72)

300 REM DO IT

31Ø INPUT N%

320 SYS 840

33Ø PRINT N%

BML 7B

10 REM PROGRAM 7B

20 REM TRANSFER DATA BY VARIABLE ADDRESS--NOT RELYING ON PAGE Ø SPACE

3Ø FOR AD=84Ø TO 866: READ B: POKE AD, B: NEXT

4Ø DATA 173,6Ø,3:REM LDA 828

5Ø DATA 133,251:REM STA 251

6Ø DATA 173,61,3:REM LDA 829

7Ø DATA 133,252:REM STA 252

8Ø DATA 16Ø,1:REM LDY #1

90 DATA 24:REM CLC

100 DATA 177,251:REM LDA (251),Y

11Ø DATA 1Ø5,2:REM ADC #2

120 DATA 145,251:REM STA (251),Y

13Ø DATA 136:REM DEY

140 DATA 177,251:REM LDA (251),Y

15Ø DATA 1Ø5,Ø:REM ADC #Ø

16Ø DATA 145,251:REM STA (251),Y

17Ø DATA 96:REM RTS

200 REM GET ADDRESS

210 N%=0:POKE 828,PEEK(71):POKE 829,PEEK(72)

300 REM DO IT

31Ø INPUT N%

320 SYS 840

33Ø PRINT N%

BML 8

32Ø SYS 84Ø

33Ø PRINT N\$

0

0

10 REM PROGRAM 8 20 REM TRANSFER DATA BY VARIABLE ADDRESS—STRINGS 30 FOR AD=840 TO 874:READ B:POKE AD,B:NEXT	0
4Ø DATA 16Ø,1:REM LDY #1 45 DATA 177,251:REM LDA (251),Y 5Ø DATA 133,253:REM STA 253	0
55 DATA 200:REM INY 60 DATA 177,251:REM LDA (251),Y 65 DATA 133,254:REM STA 254	0
7Ø DATA 16Ø,Ø:REM LDY #Ø 75 DATA 177,251:REM LDA (251),Y 8Ø DATA 141,6Ø,3:REM STA 828	0
85 DATA 177,253:REM LDA (253),Y 90 DATA 201,36:REM CMP #'\$' 95 DATA 208,4:REM BNE +4	^
100 DATA 169,92:REM LDA #'{POUND}' 105 DATA 145,253:REM STA (253),Y 110 DATA 200:REM INY	J
115 DATA 204,60,3:REM CPY 828 120 DATA 48,240:REM BMI -16 130 DATA 96:REM RTS	0
200 REM GET ADDRESS 210 N\$="":POKE 251,PEEK(71):POKE 252,PEEK(72) 300 REM DO IT	0
31Ø INPUT N\$	

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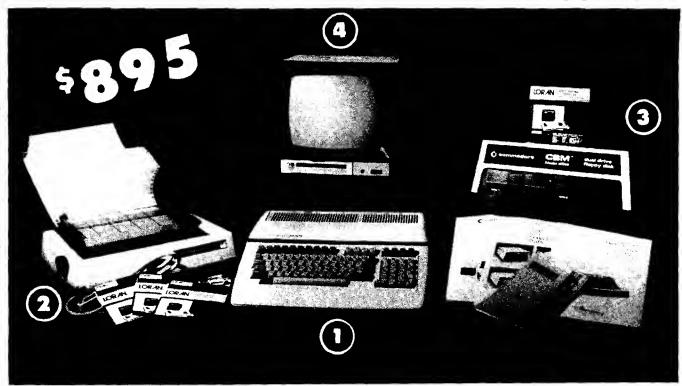
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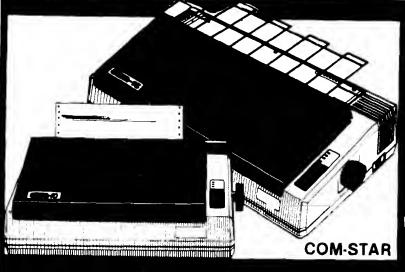
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Rational

Joystick

Interfacing

by Charles Engelsher Schenectady, New York

A 'Build-it-yourself' project that lets you explore Analog/Digital techniques.

Introduction

Sometimes a seemingly mundane project like joystick interfacing can hold a few educational surprises. For the hardware beginner it provides an opportunity to complete a simple and useful item that is at the same time safe for your Apple and easy on the pocketbook.

More than that, joystick interfacing embraces concepts that have widepread application in other areas of computer hardware: concepts like single-bit A/D conversion, the RC time constant, efficient use of built-in Apple monitor routines, the use of resistive transduction as a basis for measuring physical quantities and proper software scaling of parameters for screen display.

Obviously, this article is more than just a description of a simple project. It provides a vehicle for introducing important hardware ideas to the novice as well.

Analog to Digital Conversion

In the real world, physical quantities vary continuously. A quantity such as temperature or position can literally assume an infinite number of values, even over a narrow range. Digital quantities, on the other hand, vary in a discrete fashion. Simply put, A/D conversion involves translating a continuous physical quantity to a digital format — into zeros and ones.

In all versions of A/D conversion the physical quantity is first converted to an electrical quantity. For instance, a thermistor translates temperature into a resistance, while thermocouple would convert temperature into a voltage level. Such transducers are really doing nothing more than providing an electrical analog of the quantity being measured. This analog signal could be fed to an amplifier, and then to some display device such as a meter.

A/D conversion takes this signal one step further by translating it into digital form. One way of doing this is through multibit conversion, as illusrated in Fig. 1A. You need only supply the right analog signal in the proper range of voltage (or current), and the A/D integrated circuit will output an 8-bit data word which can then be read off the computer data bus. The device shown has an "8-bit resolution." It provides 256 discrete values — 000000000 through 11111111 in binary. This scheme would be quite adequate for temperture measurement between

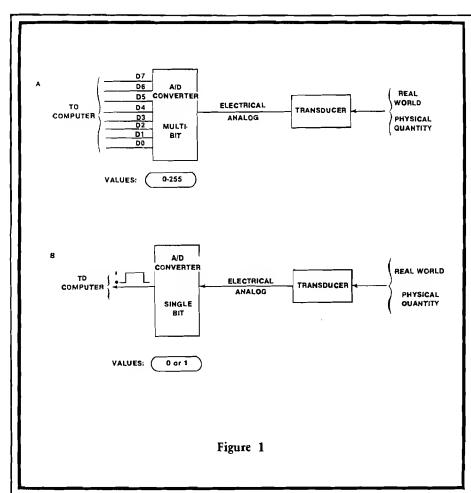
the freezing and boiling points of water. Resolution would be 1 degree Fahrenheit or 1/2 degree Celsius, with a short range on either side of these points.

Now suppose you have only a single output line for the digital data. As you can see from Fig. 1B, the output of such a "single-bit A/D converter" is a simple square wave. This is the situation you're presented with on the Apple game port analog (paddle) inputs. Can you make this singlebit — which can be either HIGH/1 or LOW0 — represent a whole range of values?

Time Constants and Oscillators

Enter the time constant. The solution to the problem of single-bit A/D conversion is to make the length or duration of this square wave vary in proportion to the analog signal. The principle involves varying the resistive-capacitative or RC time constant.

You're probably familiar with mechanical time constants from every day experience. Time constants are best described in terms of exponential rises and falls in some physical property of a system, be it velocity, volume or whatever. Often, the time constant can be used to cause periodic or oscillatory motion in the system. Swinging pendula, flushing toilets and



plucked strings all have intrinsic time constants that determine how fast they swing, how quickly they fill and at what pitch they vibrate. The RC time constant, the basis of most single-bit A/D conversion schemes, has the same implications for electrical systems.

The RC time constant determines how quickly a capacitor "fills" with electrons when a voltage is applied. Fig. 2A shows what happens when you apply a voltage to a resistor and capacitor in series. The time constant is equal to the resistance in ohms times capacitance in farads. For the circuit shown, the time constant (TC) is 1 second (1 ohm x 1 farad). The charging curve is shown to the right of the circuit. After two TC's it will be about 86 percent charged. After three TC's the capacitor will be charged up to 95 percent of the applied source voltage (Vs), about .95 volts.

Fig. 2B shows the case for discharge of the capacitor after it has been charged to the applied voltage Vs of 1 volt. In this case it will be about 63 percent discharged after one TC, 86 percent discharged after two and about 95 percent discharged after 3TC's. Notice that the percentage figures are



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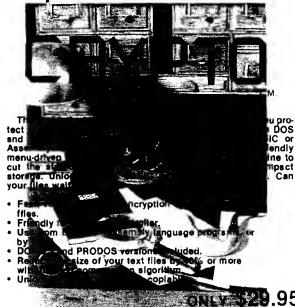
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The formulae below the two curves describe the voltage rise and fall in the capacitor in terms of the natural logarithm, e, which equals 2.718. Its reciprocal is .37. If you measure charge or discharge in absolute time T, then the term e-T/RC is used. If you measure time with respect to the number of RC time constants that have passed {N}, this term becomes {.37-N}.

The key point of all this is that the time constant is a basic property of RC circuits. If you change either the capacitance or the resistance, you change the time constant. (At this point we're only a few short steps away from practical single-bit A/D conversion on the Apple, so stay tuned a bit longer.)

Rather than belabor the physics of the situation, consider what happens if you could attach an RC circuit to an active electronic device, one which could provide a periodic charging and discharging current to the capacitor. By connecting a resistor and capacitor to one type of integrated circuit you can produce oscillations.

For the device shown in Fig. 3A, the output will be a train of square waves. The period between successive square waves is indicated by "T" in the figure. The reciprocal of this period is the frequency of the signal. This frequency can be varied by changing R or c. In this circuit a variable resistor or potentiometer (technically called a rheostat) is illustrated, as this is the easiest way to change the frequency of the square wave signal.

The oscillator is not the ideal way to achieve single-bit A/D conversion, however. One reason is that the output frequency of such oscillators (the 555 timer being one example) does not change in direct proportion with changes in the resistance. Another reason is that the software necessary to measure frequency is more complex and takes longer to execute than the preferred method: the ONE-SHOT.

One-Shots

A simplified circuit for the preferred method of single-bit A/D conversion is shown in Fig. 3B. One-shots produce a single square wave pulse when set off by a brief trigger pulse and come in integrated circuit (IC) form. For many commonly available one-shot IC's, the duration of the square wave output is exactly equal to the time constant, that

is, the product R x C. Not only that, but the variation of the duration of pulse width varies linearly with [in direct proportion to] the variable resistor.

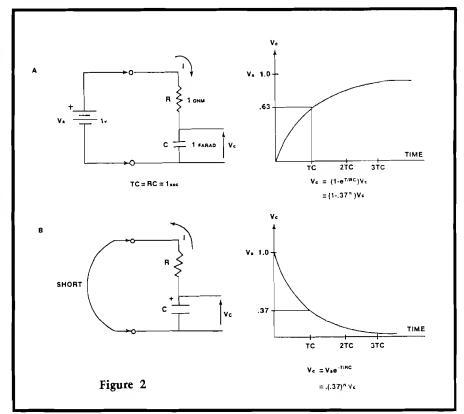
Single-bit A/D conversion using one-shots entails the same steps as that for multi-bit conversion:

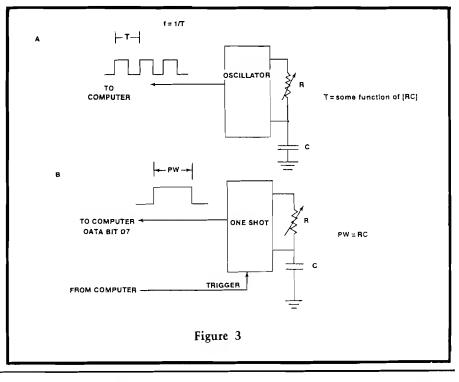
1. transduction of a physical quantity into an electrical analog — current to charge the capacitor in this case, followed by

2. production of a digital output -a square wave whose pulse width is proportional to the RC time constant (PW = RC).

With the capacitance value held constant, the pulse width will be proportional to the resistance.

This is exactly the scheme for A/D conversion used on the Apple's game port analog, or paddle, inputs. In the Apple there are actually four one-shots on one integrated circuit, the "quad





558 timer" as it is called. Each oneshot on this IC is connected to its own pin on the game socket, to which in turn the user plugs in a variable resistor (paddle). Two paddle inputs can be paired, with one for screen x-axis and one for y-axis. This allows for x,y display of a shape on the screen through a joystick or similar device.

The only missing ingredients for our joystick project are the details of the joystick circuitry and software routines used to measure the pulse width and display results to the screen. These two elements are interrelated and will be covered together.

A Practical Joystick Circuit for Apple

Fig. 4 summarizes the main elements in any paddle input A/D conversion scheme: the given software, calculations for matching time constants and the basic circuit.

For a 100K pot this becomes:

TO BIT

BUS

D7 ON DATA

Figure 4

C2 = 3300 uf/100K - .022 uf

= .Ø11 uf

\$C070

PW = RC

TRIG

558

R1 = 100 ohm

 $C_1 = .022$

Let's look at the software first. Apple's PREAD (paddle read) is a built-in monitor subroutine which measures the pulse width of a square wave. PREAD is located at \$FB1E (64286 decimal) in the monitor. It must be entered with the paddle number (0, 1, 2 or 3) in the X-register. This is done automatically with the PDL command from BASIC, but must be done "manually" with a LDX command if you are programming in assembler.

The first step in PREAD is to trigger the one-shot so that the square wave output is initiated. This is done by accessing location \$C070 (STA would work just well as LDA). The Y-register is used as a counter and is set to zero. The two do-nothing commands (No OPeration) are used to fine tune the counting for the first count.

The body of PREAD is the loop beginning at PREAD2. With the paddle number in the X-register, PREAD2 checks the status of the most signif-

icant data bit (D7). If D7 is zero (positive number in binary notation), then the square wave must have returned to zero and you exit PREAD. If D7 is binary one, then the Y counter is incremented and the count continues.

However, if Y is incremented past \$FF (255) it becomes zero; this constitutes an overflow and you again exit the routine (after decrementing Y back to 255).

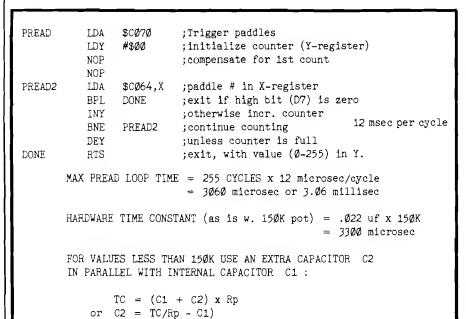
The value of the paddle returned to the calling routine by PREAD will be in the Y-register. The calling routine (e.g., in BASIC or assembler) will then process this value for display or other purposes.

PREAD takes 12 microseconds, or about 3.06 miliseconds for a full count of 255. Compare this with the maximum hardware RC time constant on the paddle. With the standard 150K paddle potentiometer provided in an Apple paddle and the .022 uf internal capacitor on the main board circuitry, the maximum TC is about 3.3 millisec, roughly 8 percent more than the maximum PREAD loop time. This excess is a safety factor; the paddle pot could fall a bit short in its full scale resistance and still return a full count of 255.

All you have to do is get a surplus 150K joystick and you're in business, right? Not quite. When you go to purchase a "bare" joystick, you'll have one heck of a time finding one with 150K pots. (Unless you want to spring \$50 or \$60 for a commercial joystick.) Surplus and mail order 100K joysticks are readily available for three to five dollars, however.

Obviously, with such a low resistance, some capacitance must be added to each pot in the joystick in order to bring the maximum RC time constant up to an acceptable level. A value of 3.3 milliseconds for TCmax is used, as this duplicates the safety margin of Apple joysticks. The circuit for one paddle input is given in at the bottom of Fig. 4.

By adding a capacitor, C2, in parallel with the main board capacitor, C1, the TC value of 3.3 msec can be realized. The capacitances are simply additive in parallel configuration. [The small current limiting 100 ohm resistor can be ignored.] The calculation for this added capacitance is given in the figure. For a 100K pot C2 will be .011 uf. A value of .01 uf is a good starting approximation; any additional capacitance can be added in parallel to this if needed.



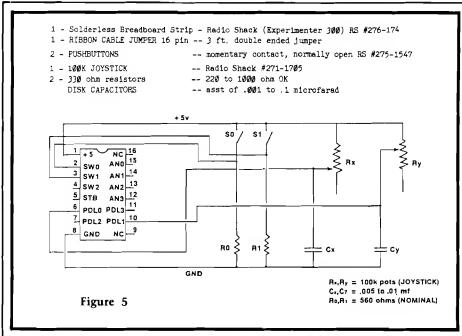
GAME PORT

PADDLE INPUT

(PINS 6, 10, 7, 11)

O-100K

C2 = 0.011 m



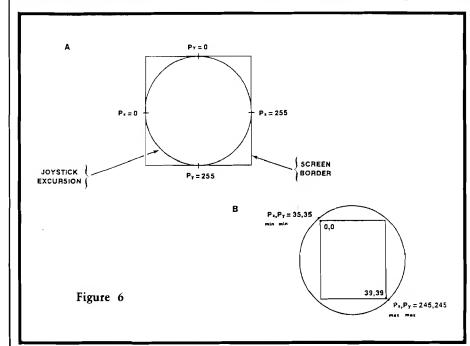
The whole circuit and parts list is given in Fig. 5. The actual cost of the parts used will probably be about \$10 to \$15 dollars. It's best to use a solderless breadboard strip (Experimenter 300 available from Radio Shack) to breadboard the circuit before wiring it up in a permanent configuration. Plug one end of the dual ended DIP (dual-in-line package) jumper into the game socket on Apple's main board and park the other end into the breadboard. You can omit the pushbutton switches for the initial circuit if you wish.

Arbitrarily, paddle 0 has been assigned as the X-axis paddle and paddle 1 as the Y paddle. These assignments can always be changed later in software if desired.

Software Scaling

Once you've installed the circuit on the solderless breadboard, you must test it out. An easy method entails use of the LORES screen, but keep in mind that with any screen display there is a difference between screen shape and joystick execution. Fig. 6 illustrates this disparity.

Assume for the moment that you're writing the software to display a LORES joystick-moveable screen cursor. With a short routine such as the one in Listing 1, you'll have a clear idea of the values returned as the joystick moves about and within its circular boundary. If you use the maximum values at each edge of X,Y



Listing 1

96	REM
97	REM PADDLE VALUES
98	REM
99	REM
100	HOME
11Ø	$PX = PDL (\emptyset): PY = PDL (1)$
12Ø	PRINT PX, PY
1301	GOTO 11Ø

paddle excursion (0 and 255), then the cursor will never reach the corners of the screen. The reason for this is given in Fig. 6A.

Instead, you must be sure to scale the values returned from the joystick so that the joystick's excursion includes the corners of the screen. As an example, let's say that the potentiometer X,Y values returned from the upper left hand corner (Px,min and Py,min) are 35 and 35, respectively. Similarly, assume that the maximum paddle values at the lower right hand corner are 245 and 245 (Px,max and Py,max). This is shown in Fig. 6B. Software must convert these values to the graphics screen ranges.

Note: Since you are breadboarding the circuit, you should freely change Cx and Cy and test the Px and Py values returned from Listing 1. Begin with Cx and Cy values calculated earlier. If the .01 uf values are too high, begin with .005 uf and add capacitance in .001 uf increments. This will allow you to achieve the 240 to 250 range for Px, max and Py, max. Once you've empirically optimized Cx and Cy values, you can proceed.

In this example we'll develop a short equation to convert paddle values to mixed LORES coordinates. The equation for the X axis for LORES is given in Fig. 7. The LORES X value will fall in the range of 0 to 39. Sx is the scale factor, Px the current value returned from paddle-X, and Px, min is the value returned from the upper left hand corner of the screen.

The equation for Sx, which depends on Px,min and Px,max, is also given in Fig. 7. Allow a little "dead space" on either side of the extreme points of upper left to lower right excursion; this improves joystick action, as you don't have to jam it at the limit of travel to get the max and min values. Dead space is illustrated in Fig. 6B by the shaded area. Letting Px,max = 240 and Px,min = 40, Sx becomes .196 {raised up one-thousandth.}

$$X = S_x(P_x - P_{x,min})$$

$$S_x = \frac{X_{MAX}}{P_{x,max} - P_{x,min}} = \frac{39}{240 - 40} = .196$$

$$PROGRAM STATEMENT: X = INT(.196 * (P_x - 40))$$

$$SIMILARLY FOR Y: Y = INT(.196 * (P_y - 40))$$

$$Figure 7$$

In BASIC format, the equation becomes "X = INT(.196*|Px-40|)" for the X-axis. A similar calculation and equation is involved for the Y-coordinates (0 to 39 also in mixed mode).

The routine in Listing 2 will display a LORES ''boxel'' on the screen using the scaling equations and print out the paddle values and X,Y coordinates.

Once you're satisfied with joystick operation, you can hook up the circuit in Fig. 5 as a permanent installation. Use a 16-pin IC socket mounted on a piece of perfboard cut to serve as a lid for a plastic project box. Radio Shack has these materials. Mount the socket at one end and the joystick behind it. The pushbuttons should be mounted on either side of the box underneath the socket. You need only to insert the DIP jumper plug into this homemade joystick and you're in business.

Listing 2

96	REM
97	REM LORES JOYSTICK DEMO
98	REM
99	REM
100	HOME : GR
11Ø	$PX = PDL (\emptyset):PY = PDL (1)$
12Ø	X = INT (.196 * (PX - 40))
	Y = INT (.196 * (PY - 40))
130	IF $X < \emptyset$ THEN $X = \emptyset$
14Ø	IF $X > 39$ THEN $X = 39$
15Ø	IF $Y < \emptyset$ THEN $Y = \emptyset$
16Ø	IF $Y > 39$ THEN $Y = 39$
17Ø	$COLOR = \emptyset: PLOT XT, YT$
1 8Ø	COLOR = 1: PLOT X,Y
19Ø	XT = X:YT = Y
2ØØ	PRINT ''PX/X: '';PX;''/'';
	X,''PY/Y: '';PY;''/'';Y
210	GOTO 110

Summary and Suggestions

At this point you know how to construct your own joystick for about 1/4 the price of a commercial unit. If you followed the sequence up to joy-

stick construction, you've learned a bit about the RC time constant, one-shots and time interval measurement from assembly language — that is, about single-bit A/D conversion using a resistive transducer. For the example shown, the conversion was from angular position (a continuous real world quantity) to LORES coordinates (digital quantity). Below are a few project suggestions.

You may want to incorporate the method for scale calculation in a routine that automatically calculates the proper scale factors for X and Y. Sx and Sy could then be customized for any joystick, whether homemade or commercial. Such a feature would be useful in games and much appreciated by the game player. Hint: use pushbuttons or keyboard to signal the upper left and lower right corners of the joystick's excursion.

You may also want to apply the same method presented here to develop the scaling equations and BASIC statements for HiRes display. You'll have no trouble with the Y-coordinates [0-191], but since the X-coordinate can range from 0 to 279, some compromisc will be necessary. You have two choices:

1. Use the full scale of the X-axis [0 to 279] and calculate Sx accordingly. This method will result in "dropout" or non-plotting of a few points along the X-axis, but it does give a full range of X motion when this is needed.

2. Omit plotting the edges of the X-axis — say 40 points on either side. This leaves 200 points or so in the central portion of the X-axis and prevents full X-axis excursion, which may or may not be a drawback in certain applications. It does, however, provide a point-for-point correspondence between joystick position

and screen positioning of a cursor or other shape, a necessary feature in some instances.

An entirely different set of applications for single-bit A/D conversion is the use of transducers other than joysticks. You might want to use a cheap resistive photocell (e.g., Radio Shack 276-116) as a light transducer. Check its resistance in the range of light intensity you want to measure with an ohmeter, and calculate the value of added capacitance if needed. Thermistors, which change resistance in response to temperature changes, provide another possibility for experiment. Brands such as Fenwall are available through overthe-counter and mail order parts distributors

Those of you who are comfortable with assembly language might want to modify the PREAD routine in one or more of the following ways:

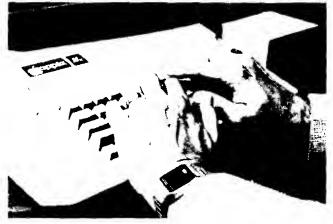
Write a PREAD routine that will use double precision counting, that is, one which increments a 16-bit counter consisting of two memory locations. Ideally, these should be in page zero to increase execution speed. Values returned will be in the range of 0 to 65535. This is a dramatic increase in range of measurement. Naturally, speed will be proportionally reduced so that the sampling rate will be little better than once per second.

Have your modified PREAD store a memory page (256 bytes) or more of data automatically, under user control. This maximizes the speed of PREAD, as all the data is dumped into memory in quick succession. The data can then be analyzed and displayed later on. For proper display, you should make sure that the sampling intervals between each data element are equal.

Finally, for joystick applications, modify PREAD to read the X and Y resistors in sequence. Naturally, two page-zero memory locations are the best choice for the X and Y counters. The advantages of such a dedicated PREAD routine are two: you avoid the problem of inaccuracy when you trigger two paddle inputs in succession, and you significantly increase joystick reading speed.

These suggestions just scratch the surface. Some applications will require a little electronics background. A little study on the use of operational amplifier IC's [which boost sensitivity of certain transducers] will serve you in good stead if you pursue this subject.

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68000 p-System BASIC

by Paul Lamar Rendondo Beach, California

& Charmaine Lindsay Willowdale, Ontario, Canada

There is nothing more boring than a standardized computer unless it is a standardized high level language. Computer hardware design, operating system design and high level language design is almost an art form. Just the right combination of characters and lines on the screen, the right feel to the keyboard, the proper ergonomics, etc. You can always use more speed, RAM and disk storage, of course. There are those who would standardize both hardware (IBM PC ??) and software. This I think would be a mistake. Computer design, operating systems and high level languages are living and growing things just as are common languages (English for example). With 16 megabytes of memory addressing on the 68000 microprocessor and 100 megabyte, five inch winchester hard disks available, we have a long way to go in micros, micro operating systems and in high level computer languages. I don't think we should stop here.

BASIC is the easiest to use, most versatile High Level Language (HLL) so far. It is easy to learn and fun to write short programs in. This article is about a better BASIC.

The p-System has a very nice compiler BASIC written by Softech Microsystems. This BASIC will run on any machine that runs the p-System. That includes, but is not limited to. 68000 SAGE Pinnacle Micro Craft Dimension, Hewlett Packard 9816, Corvus Concept, Analytical Engines Saybrook and last, but not least, the 8088 IBM PC and all its clones that have implemented the p-System. Needless to say, it runs about four times faster on a 8 megahertz 68000 such as the SAGE than it does on an IBM PC. The p-System BASIC has all

the usual basic commands and constructs such as IF THEN ELSE, FOR TO STEP NEXT, ON GOTO and ON GOSUB, PRINT USING etc. In addition, it has some unusual extensions.

Units

The UNIT statement is very unusual and can be used to write BASIC programs that can be called from another BASIC program, or a FORTRAN or Pascal program. This is done by storing the BASIC program UNIT on disk or in RAM disk within a "LIBRARY" of other UNITS. UNITS are a concept originally borrowed from assembly language by Pascal. The author of Pascal merely changed the name from "Called Module" to "UNIT". This is quite typical of Pascal and other high level languages. UNITS are a form of modular programing because they can be separately compiled and debugged in the same way as Called Modules can be separately assembled and debugged in assembly language.

Believe it or not, you can call a subroutine (called PROCEDURE in Pascal, subroutines being dirty words in Pascall from within this wonderful BASIC. There are quite a few Pascal PROCEDURES available to run on the p-System that you may want to use in your BASIC programs. The way you do this is as follows

REM These commands are imbedded in the BASIC program.

LIBRARY "UNIT2.LIBRARY"

"UNITS". These "UNITS" are name (see Figure 2.)

separate, short PASCAL programs that have PROCEDURES (subroutines) imbedded within them, just as a BASIC program has subroutines imbedded within).

USES FANCONTROL

FANCONTROL is the name of a UNIT that controls the fan. What else?}

CALL FANON

(Finally we get around to calling the actual subroutine (I'm sorry PRO-CEDURE ... shame on you, Paul) that does the trick.)

We only have to use "LIBRARY" and "USES" once, at the beginning of our BASIC program. From then on we can "CALL" FANON as many times as we

Line Numbers

A very nice real feature of this BASIC is the fact that it does not need line numbers. Line numbers are only needed for GOTOs, Subroutines and IF THEN ELSE. This feature allows rapid programing because you can use the editor to replicate blocks of code. To illustrate, let's take a block of code such as Figure 1. This block of code is a general purpose input routine with error checking. If we use the program editor's copy feature to repeat this block of code over and over again we can, with minor modifications to the block, use this same block to enter many different variables into our program. After we replicate the block, we put the editor in the exchange mode (This is the name of a file on disk or in and run the cursor down changing one RAM disk that holds a selection of character in each different variable

Another advantage of the scarcity of line numbers is the possibility of rearranging the code after you have finished programing. Rearranging the code also makes it much more understandable and easier to follow. Rearranging the code makes the program neat and progress in a logical manner, one of the claimed advantages of Pascal. No need to learn structured programing. Forget all that "top-down" nonsense. No need to structure your program, just blurt out your ideas. Get that tricky subroutine, or algorithm you having been thinking about, off your chest. You can clean it up later with this editor. This is the way to have fun, enjoy life and experience real freedom in programming.

You move code in the editor by first deleting the block of code that you would like to move. Sounds contradictory but don't worry it works. You will get used to it. What really happens is all code that is deleted goes into a Copy Buffer in RAM. It stays there until you delete the next block of code which will then overwrite the Copy Buffer. To get the last block of code, that you deleted back out of the Copy Buffer, you put the cursor where you would

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If you are knowledgeable on the 68000, please share your information with the rest of us. Send for our new Writer's Guide or call us to discuss your ideas.

like to have that block of code. You and later amused me. When I first then press "c" for copy. The editor started to program in BASIC on a CRT prompts "Buffer or File Name" Press b ten years ago, I always wondered why it for the Copy Buffer and the code was called "PRINT". It did not seem magically reappears where you want it, right to call it PRINT when that was

works for replicating blocks of code as use of the word PRINT in BASIC stemwell as for moving them. We are med from the early days, twenty years digressing into the operation of the ago of the language when all they had p-System editor which is a whole other was a teletype printer as input/output story by itself. Back to p-System for their computers running BASIC. BASIC.

Variables

Another nice feature of this BASIC is that variables are significant up to 8 characters. This makes the code largely self commenting. It also makes it quite easy to come up with new meaningful names and lessens the need for local variable names. The worst of the early BASICs only allowed one letter followed by one number (A1, G9, etc.). Later BASICs, such as Applesoft, would allow as many letters as you like but would only consider the first two as significant. BUTTOCKS and BUSTY are the same variable names in Applesoft. (That's the one remaining trouble with computers, they lack sensuality.

Display and Print

DISPLAY of course, displays it on the CRT and PRINT actually prints the results on a real printer. The PRINT command in BASIC at first confused

The same sequence of commands done on a "printer" not on a CRT. The DISPLAY makes more sense if you are going to display it on a CRT.

Image

The IMAGE statement appears to me an another unusual feature. I am not what anybody would call an expert on BASIC languages. I am familiar with Microsoft basic as implemented on the Apple, Commodore and CP/M. IMAGE to my knowledge does not appear in Microsoft basic. The IMAGE statement is referred to by line number within the USING clause of a DISPLAY or PRINT statement. For examples:

Example 1:

A = 88.888 (note the lack of a line number and the LET statement) 10 IMAGE ###.## (line number required here!

PRINT USING 10:A (again no line number

The printer prints "88.89" with the .888 rounded to .89.

1	2	1:Ø	Ø	rem fig. 1			Figure
2	2	1:Ø	12	10 116. 1			
3	2	1:Ø	12	input "1st	variable	2	":variable1
4	2	1:Ø	43	Input 100	, a1 1 a5 10	•	
5	2	1:Ø	43				
6	2	1:Ø	43				
7	2	1:Ø	43	rem fig. 2.			Figure 2
8	2	1:Ø	43	10 116. 2.			2-0
9	2	1:Ø	43				
1ø	2	1:Ø	43	input "1st	variable	?	":variable1
11	2	1:Ø	74	input "2nd			":variable2
12	2	1:0	105	_			":variable3
13	2	1:Ø	136	-			":variable4
14	2	1:Ø	167	_			":variable5
15	2	1:Ø	198	•			":variable6
16	2	1:0	229	-			":variable?
17	2	1:0	260	input "8th			":variable8
18	2	1:Ø	291	•			
19	2	1:Ø	291				
20	2	1:Ø	291	end			

Example 2:

S\$ = "The subtotal is" **DISPLAY USING 10:S\$,A**

"The subtotal is 88.89", is displayed on the CRT.

Example 3:

20 IMAGE \$\$###.## (The double dollar sign indicates a floating \$1

PRINT USING 20:S\$,A

The printer prints "The subtotal is \$88.89''.

You don't have to use IMAGE. PRINT and DISPLAY USING works in all the usual ways just like Microsoft BASIC.

Disk File Handling

There are the usual OPEN and CLOSE statements for RELATIVE and SEQUENTIAL disk files. RELATIVE files allow sequential and random access at the expense of extra verbiage. SEQUENTIAL files are of fixed or variable length. There is a RESTORE statement that is used to reposition the internal file pointer to the first record within a SEQUENTIAL disk file. The RESTORE statement is used to reposition the pointer to a specific record within a RELATIVE file.

The ASSIGN statement is used to set up an array on disk just as most BASICs set up ordinary arrays in RAM. This frees up some RAM for use by the program. It also results in a permanent record of the array in case of power failure. Having an array on disk is slower, of course, than having it in RAM. The ASSIGN statement seems a little redundunt with the 68000 as the 68000 can directly address 16 megabytes of RAM. Perhaps this feature would become more useful if the maximum size of the arrays was 10 mega elements rather than only 32K elements. That way a hard disk could be used to real advantage. The RAM disk option can be used with the ASSIGN statement to allow larger programs that run almost as fast as arrays located in ordinary RAM. Unfortunately, considering the large memory addressing capabilities of the 68000, arrays larger than 32K are unallowed in ordinary RAM as well.

Ease and Speed of Programing

When writing BASIC programs that needed compiling on lesser operating systems than the 68000 running the The Documentation p-System you had to: write the proon disk and the program will run very to just call it a subroutine. By the way, the screen in case you forget.

program, the compiler will stop and seconds and the cursor will be placed are similar to Pascal.

just beyond the error. This is really nice if you program the way I do, by the trial and error method.

gram, save the resulting text file on An interesting aspect of this BASIC is disk, load the compiler from disk, that: in some cases the description of reload the BASIC text file from disk, the constructs and statements are writcompile the code saving the resulting ten from the point of view of the Pascal code file on disk, load the compiled programer. It is as if the authors of this code from disk and run the program. BASIC finally realized the limitations This was a long and tedious process of Pascal and set out to write a BASIC usually taking several minutes. On the that incorporated the better aspects of 68000 p-System you merely press "Q" UCSD Pascal. For example, when for quit the editor, "U" for update the discussing subroutines the authors imwork file (a temporary file in RAM) and mediately lapse into a discussion of "R" for run the program. The text file "procedure blocks". For some reason will automatically be compiled, saved they could not quite bring themselves quickly. These prompts are always on there are subroutines in assembly language and they work exactly the If you have a syntax error in your same way as they work in BASIC.

On the whole the documentation is prompt: Continue? Quit? or Edit? If quite good with lots of examples. you press "e" or "E" for edit the However it is not written for beginners BASIC text file will be automatically and some knowledge of Pascal would reloaded from RAM disk in several be helpful for those few constructs that

Basic Co	omp i l	er IV.	Ø b5-	4 SYSTEM.WRK.TEXT	
_	2	1:0	ø	{\$N+} for x=1 to 9	Figure 3
2	2	1:Ø			
3	2	1:Ø	57	display "paul"	
4	2	1:Ø	74	next x	
5	2	1:Ø	76	end	

inal MC	68ØØØ	7 IV.Ø2 [a.1] Co	de for	RAD	IX 1Ø
segment	PRO	GRAM procedure	1 MP	.EQU	AØ
segment	Word	d offset 17	BASE	.EQU	A1
Source O	bjec	t	SEG	.EQU	A2
-Code N	-Code	е	PME	.EQU	A3
Dec. Of	fset	3)	DATA	.EQU	A6
	====		=== =================================	:=== == = =	: :::::::::
	Ø			.WORD	204,0
	Ø				
4:		86Ø1	;p-code	LAO	1
		ØØ	;p-code	SLDC	Ø
	3	8114ØØ	;p-code	LDCI	•
	6	ØØ	;p-code	SLDC	Ø
	7	7Ø15	;p-code	SCXG	KERNAL ,21
	9	ØØ	;p-code	SLDC	Ø
	1Ø	A5Ø1	;p-code	SRO	1
19:	12	A8	;p-code	NATIVE	
	13	A8	;p-code	NATIVE	
	14	49E9 ØØØC		LEA	12(BASE),A4
	18	99CE		SUBA.L	DATA,A4
		3ØØC		MOVE.W	
	-	334Ø ØØ1C		MOVE.W	

The Native Code Generator

This feature of the UCSD p-System is the one feature that I am most excited about. The Native Code Generator, generates a partial assembly language text file from a BASIC program listing. See Figures 3 and 4. Unfortunately, at this time the file is part assembly language and part p-code text file, [the BASIC compiler normally generates p-code which is executed by a p-code interpreter]. At the present time, June 1984, there is a bug in the Native Code Generator that does not handle backward GOTOs in BASIC properly.

The original purpose of the Native Code Generator was to bypass the p-code interpreter and thereby speed up the execution of all high level languages running under the p-System. This is a worthwhile and highly desireable goal for the Native Code Generator. The use I have in mind is quite different however.

In way of explanation the high level language "C" also generates an assembly language text file which must then be run through an assembler to generate an executable code file. This intermediate assemble language text file form gives the programer the opportunity to exercise detailed control over the speed of execution of all parts of his program. This is the reason that "C" is the preferred high level language for writing operating systems that control time critical hardware such as disk drives and printers. My own opinion is that time critical operating systems are best written in assembly language.

As a general purpose high level language "C" is a little too cryptic for my taste. I prefer BASIC. In Softech p-System BASIC however, running the Native Code Generator generated assembly language text file through an assembler is not possible at the present time. If the Native Code Generator was expanded to convert the entire BASIC text file to an assembly language text file it would then be possible to run that assembly language text file through an assembler and generate a executable machine language code file. The same as in "C". This would result in unprecedented flexability for this BASIC. A programer could optimize the resulting assembly language text file for speed or change it for detailed hardware control. This would give the best of both worlds, the speed, flexability

Figure 4 continued

26:	26 3F29 ØØ1C		MOVE.W	28(BASE),-(SP)
	3Ø 3F3C ØØØ1		MOVE.W	#1,-(SP)
	34 4EAB ØØØ8		JSR	8(PME)
	38 CC	;p-code	FLT	,
	39 F4	;p-code	STRL	
31:	4Ø A8	;p-code	NATIVE	
	41 A8	;p-code	NATIVE	
	42 49E9 ØØ14		LEA	20(BASE),A4
	46 99CE		SUBA.L	DATA,A4
	48 3FØC		MOVE.W	A4,-(SP)
	5Ø 3F3C ØØØ9		MOVE.W	#9, -(SP)
	54 4EAB ØØØ8		JSR	8(PME)
	58 CC	;p-code	FLT	
	59 F4	;p-code	STRL	
36:	6Ø A8	;p-code	NATIVE	
	61 A8	;p-code	NATIVE	
	62 6Ø1A		BRA	L1
38:	64 3F29 ØØ1C	L3:	MOVE.W	
	68 3F29 ØØ1C		MOVE.W	28(BASE),-(SP)
	72 4EAB ØØØ8	,	JSR	8(PME)
	76 F3	;p-code	LDRL	
	77 A8	;p-code	NATIVE	#1,-(SP)
	78 3F3C ØØØ1 82 4EAB ØØØ8		MOVE.W	8(PME)
	86 CC	rn ande	JSR FLT	O(FFE)
	87 CØ	;p-code ;p-code	ADR	
	88 F4	;p-code	STRL	
	89 A8	;p-code	NATIVE	
47:	9Ø 3F29 ØØ1C	L1:	MOVE.W	28(BASE),-(SP)
	94 4EAB ØØØ8	22.	JSR	8(PME)
	98 F3	;p-code	LDRL	- (/
	99 A8	;p-code	NATIVE	
	100 49E9 0014		LEA	20(BASE),A4
	104 99CE		SUBA.L	DATA,A4
	1Ø6 3FØC		MOVE.W	A4,-(SP)
	1Ø8 4EAB ØØØ8		JSR	8(PME)
	112 F3	;p-code	LDRL	
	113 CE	;p-code	LEREAL	
	114 A8	;p-code	NATIVE	
	115 A8	;p-code	NATIVE	(-p) pd
	116 3Ø1F		MOVE.W	(SP)+,DØ
	118 E258		ROR.W	#1,DØ
	12Ø 642C		BCC	L2
57:	122 4EAB ØØØ8 126 721A	.m. aada	JSR SCXG	8(PME) BLIB ,26
٤٥.	128 7225	;p-code ;p-code	SCXG	BLIB ,20
59: 61:	130 7247	;p-code	SCXG	BLIB ,71
63:	132 A8	;p-code	NATIVE),/I
٠,٠	133 A8	;p-code	NATIVE	
	134 3F3C ØØ18) p 0000	MOVE.W	#24,-(SP)
	138 3F3C ØØØ8		MOVE.W	#8,-(SP)
	142 4EAB ØØØ8		JSR	8(PME)
	146 9D	;p-code	LPR	
	147 A8	;p-code	NATIVE	
	148 3F3C ØØ1Ø		MOVE.W	#16,-(SP)
	152 4EAB ØØØ8		JSR	8(PME)
	156 7226	;p-code	SCXG	BLIB ,38
7Ø:	158 7247	;p-code	SCXG	BLIB ,71
72:	16Ø 722A	;p-code	SCXG	BLIB ,42
74:	162 A8	;p-code	NATIVE	
	163 A8	;p-code	NATIVE	
	164 6Ø9A		BRA	r3
76:	166 4EAB ØØØ8	L2:	JSR	8(PME)
78:	170	;exit code	זוחח	d
	170 9600	;p-code	RPU	Ø

and detailed control over the speed of execution of assembly language with the ease of programing in a simple, easy to learn high level language. This BASIC in conjunction with the p-System Native Code Generator is very close to this utopia.

Speed of Execution

Speed of execution is not what BASICs are known for. No one should write a word processing, spreadsheet, data base or spelling checker program in any BASIC, interpreted or compiled. The presently available compilers are just not as efficient as a good assembly language programer at writing code. Nevertheless, the 8 megahertz 68000 p-System compiled BASIC in p-code form is three times faster than Microsoft BASIC running on the IBM PC. Running the p-code through the 68000 Native Code Generator would speed it up by another factor of three except for the floating point routines. These routines are not changed by the Native Code Generator. Fortunately, number crunching is best done by hardware floating point chips.

National Semiconductor has a floating point chip [16081 or 32081] that works quite well with the 68000. Ironically it works faster with the 68000 than with Nationals own 16 bit microprocessor the 16032. This chip is capable of dividing a 64 bit floating point number by another 64 bit floating point number in approximately 30 microseconds with the 68000 running at 10 MHZ and the 16081 running at 5 MHZ. That is the total time required to load and retrieve the operands and store them in main memory. The 16081 requires only 11 microseconds to do the actual divide. The 16081 will shortly be available in a 10 MHZ version. This will not reduce the time by half but by somewhat less than half. The reason is that some finite time, determined by the speed of the 68000, is necessary to load the operands into the floating point chip. Eventually, p-System BASIC, or some other BASIC will be available that will support the 68000/16081 combination.

Converting Microsoft Basic to Softech p-System Basic

Using the following rules, with wise use of the p-System editor commands, you will be able to convert a typical Microsoft program to Softech p-System

BASIC in short order. Use them in the order shown to avoid confusion and mistakes. These procedures were provided by Peggy Lakey at SAGE Computer, Reno, Nevada.

You can transfer your Microsoft BASIC text files to the p-System receiving computer using a RS232 serial printer interface cable on the transmitting computer. Connect this cable to a RS232 port on the receiving computer. Any text file that can be printed on 20 X = Y :: IF X = 0 THEN 30your present printer can be transferred. The p-System in the SAGE has a utility 30 ... program called "TEXTIN". This program will convert an ASCII file to the p-System file format. The resulting Microsoft BASIC text file in the p-System computer can then be loaded into the editor and converted to a p-System BASIC text file using the following rules.

- 1. Change all occurences of ':' to "::". Then search for each of these and change back those in strings and quotes, which should not have been altered.
- 2. Put an 'END' statement at the end of the program, if not already present. All other 'END' statements should be changed to 'STOP'.
- 3. A statement such as 'DEFINT I-N' should be re-written to read 'INTEGER I, J, K, L, M, N'.
- 4. Any statement 'IF ... GOTO ..' should be changed to 'IF ... THEN..'.
- 5. Strings and literal quotes may not be continued from line to line. They must be presented on one line, or displayed in segments, or concatenated.
- 6. 'TAB (X)' must be followed by ';'.
- 7. When 'INPUT' is used with an imbedded string as prompt, use "." before the variable label, not
- 8. Change all occurences of 'PRINT' to 'DISPLAY' unless you specifically want an output to go to the printer.
- 9. Any time a single statement must be continued from one line to another, use the comment delimiters '(* < CR> ' to hide the carriage return from the compiler.

Example:

1000 IF x < y then (* *) GOSUB 300 : : DISPLAY x

- 10. When multiple statements follow an 'IF' statement on a line, those statements will not be skipped if the 'IF' statement proves false. The following line of Microsoft:
- 20 X = Y : IF X <> 0 THEN X = Z :GOTO 5

should be re-written as follows:

X = Z :: GOTO 5

- 11. Change any command that is intended to clear the screen to 'DISPLAY ERASE ALL: '
- 12. Any command intended to display at a given place on the screen, such as 'PRINT' 342', or 'HTAB 5 : VTAB 6 :PRINT' should be changed to 'DISPLAY AT (line, column):'.
- 13. When concatenating strings, use '&', not '+'.
- 14. Change 'MID\$' to 'SEG\$'.
- 15. Change 'LEFTS (X\$,L\' to 'SEG\$ ${X\$,1,L}'$.
- 16. Change 'RIGHTS\$ (X\$,L)' to 'SEG\$ (X\$,(LEN(X\$)-(L-1)),L)'.
- 17. Change 'GET' to 'INKEY\$ (0)'. (NOTE: these statements do not always act exactly alike. Check the definitions in BASIC you are converting from.)
- 18. Subscripted and non-subscripted variables of the same name are not allowed in the same program. For example, if the variable 'A[10]' and 'A' are in the same program, change them to 'A(10)', and 'A_NUTHER'.
- 19. In a DIM statement, a variable name may not be used in the parenthesis for dimension size. Thus, DIM X(B,C) is illegal. DIM X(3,4) would be ok.
- 20. Change all function statements and calls as follows: 'DEF FN F_name(args)' is changed to 'DEF f_name(args)'. (add a FNEND for multiple line functions, see manual 'FN f_name' is changed to just 'f_name'. Be sure all function names have unique names, and don't use regular variable names.
- 21. All strings in data statements must have ''quotes''d around them.
- 22. In a DIM statement, a variable name may NOT be used for the array size.

Exec File Utilities

by N. D. Greene Storrs, Connecticut

> A Collection of Eight Useful **Exec Utilities for the Apple**

Introduction

Here are eight exec file utilities which are useful in writing and examining programs on the Apple II. They may be easily entered and saved with the Textfile Write Edit Read Program (T.W.E.R.P.) described in the September 1984 issue of Micro.

Exec files are text files containing basic commands and/or program line statements. When these files are activated by the EXEC ("execute") command, they mimic direct keyboard entry. If an exec file contains only commands, it is possible to exec it without disturbing any program in memory. For example, one of the utilities described Pointer-Based Routines below prints a memory map of the current program without altering it. However, exec files containing program line statements can be used to quickly change the contents of a program. Some examples of this approach basis of an exec file. Two examples are are also described below. Further shown in Listings 3 and 4. Executing details about exec files and their E.BIN (Listing 3) prints the address and characteristics are discussed in the disk length of the last loaded binary file. operating manual.

Description

from simple command statements to mation by peeking at the appropriate more complex forms. For convenience, pointer addresses. Both of these files they have been divided into three may be used without disturbing a general categories.

Simple Command Routines

Listings 1 and 2 show two simple exec files which may be used to display the contents of high resolution graphics pages one or two without erasing them. This is in contrast to the normal HGR and HGR2 commands which activate page 1 or 2 after erasing their contents. These files should be entered as listed using T.W.E.R.P. or other text file writer. Note that the bracketed 1 with the arrow is used to indicate the first field and should not be entered. The question mark, ?, is the shorthand equivalent of the print command.

Certain memory addresses indicate the locations of program elements or variables. These addresses are called "pointers" and may be used as the Listing 4 is a shortened version of a previously published memory map exec file (MICRO 43, Dec. 1981). It finds and displays the program begin-The exec files described here range ning, the program end and other inforprogram in memory.

Piggyback Routines

Some statements such as INPUT can not be used as direct keyboard commands. These deferred-execution commands must be used within a program. The same restrictions apply to exec files. However, it is possible to use these restricted commands within an exec file without permanently altering a program in memory. This is the piggyback routine. The exec file adds some new lines to the existing program, runs these lines and then deletes them leaving the program in its original form. Typically, high line numbers are chosen to avoid conflict with existing line numbers.

Listings 5-8 show several exec files which use deferred-execution commands via the piggyback method. E.PTR (Listing 5) shows the contents of a pointer address. The initial (low byte) address is input and the program calculates and prints the contents of the two-byte address. If 103 is input, the program start memory will be shown. E.PTR adds three new highnumbered lines, the last one containing a delete command. The file then runs the lines which ask for an input, print the results and then conveniently selfdestruct. Actually E.PTR represents a combination of a piggyback and pointer exec file.

1716A

1=> POKE49239, Ø: POKE49236, Ø: POKE49234, Ø: POKE49232, Ø

Listing 1. E.GR1

MIRESI

1=> POKE49239, Ø: POKE29237, Ø: POKE49234, Ø: POKE49232, Ø: END

Listing 2. E.GR2

```
1=> HOME:?"ADD=";PEEK(43634)+PEEK(43635)*256
2=> VTAB3 :?"LEN=";PEEK(43616)+PEEK(43617)*256
```

Listing 3. E.BIN BLOSS - ADDRESS EINMITH

```
1=> HOME: "HI MEMORY= "; PEEK(115) + PEEK(116) * 256
```

116)*256 nin: 27 pm

2=> VTAB2:?"STRINGEND= ";PEEK(111)+PEEK(112)*256

3=> VTAB3:?"FREESPACE= ";

PEEK(111)+PEEK(112)*256-(PEEK(1Ø9)+PEEK(11Ø)*256)
4=> VTAB4:?"ARRAY END= ";PEEK(1Ø9)+PEEK(11Ø)*256

5=> VTAB5:?"ARRAY BEG= ";PEEK(107)+PEEK(108)*256

6=> VTAB6:?"LO MEMORY= "; PEEK(1Ø5)+PEEK(1Ø6)*256

7=> VTAB7:?"PROG END = ";PEEK(175)+PEEK(176)*256

8=> VTAB8:?"PROG BEG = ";PEEK(1Ø3)+PEEK(1Ø4)*256

Listing 4. E.MEM

```
[1]=> 60000 HOME: INPUT"A=";A
```

[2]=> 61000 HOME: PEEK(A)+PEEK(A+1)*256

[3]=> 62000 DEL 60000,62000

[4]=> RUN6ØØØØ

Listing 5. E.PTR

1=> 63999 DATA2Ø1,141,240,21,2Ø1,136,24Ø,17,2Ø1,128,144,13,
2Ø1,16Ø,176,9,72,132,53,56,233,64,76,249,253,76,24Ø,253:
FORI=768T0768+27:READV:POKEI,V:NEXT:
POKE54,Ø:POKE55,3:CALL1ØØ2:DEL63999,63999
2=> RUN63999
6 HOW COMTON CHAY25

Listing 6. E.CTR

1=> 63999 D\$=CHR\$(13)+CHR\$(4):HOME:VTAB12:
INPUT "CAPTURE FILE NAME==> ";F\$:?D\$; "ØPEN";F\$:?D\$; "WRITE";F\$:
POKE33,30:LISTØ,63998:?D\$; "CLOSE";F\$:TEXT:DEL63999,63999:END
2=> RUN63999:END CAPTURE

Listing 7. E.CAPA

- 1=> 32762 D\$=""
- 2=> 32763 PRINT D\$; "OPEN TEXT.I"
- 3=> 32764 PRINT D\$; "WRITE TEXT.I"
- 4=> 32765 POKE33,3Ø:LIST Ø,32761
- 5=> 32766 PRINT D\$; "CLOSE TEXT.I"
- 6=> 32767 TEXT:END
- 7=> RUN 32762
- 8=> DEL 32762,32767

Listing 8. E.CAPI

floating point basic and then runs it. The line deletes itself when the last statement is encountered. Pressing RESET or PR#0 restores normal printouts. Two "capture" files are shown in Listings 7 and 8. These exec files transfer floating point and integer programs into text files. But why? There are two major uses for these files: 1) to create a library of auto-writing subroutines and 2) to convert integer programs into floating point programs. Both E.CAPA and E.CAPI may be used to create a library of subroutine exec files. The desired subroutine is isolated by deleting all other lines and then captured in a file by executing the appropriate exec routine (E.CAPA for Applesoft floating point programs or E.CAPI for integer programs.) E.CAPA permits a choice of file names; E. CAPI always creates a file names "TEXT.I". Once created, these files may be used to add subroutines to new programs. E.CAPA is a one line, self-destructing, piggyback exec file similar to E.CTR. E.CAPI is a piggyback version of a program listed in page 76 of reference 2. The first line (field) contains an invisi-

E.CTR (Listing 6) makes control characters visible. Control characters,

which are normally invisible in catalog

and program listings, appear as flashing characters after this file is executed. This is a useful routine to [1] check

that all DOS commands in a program

contain a control D and (2) find hidden control characters in catalog names. If you accidently insert a control

character while saving a program on

disk, it will not load unless the invisi-

ble character is inserted at the proper point. This is a frustrating experience

and a trick used by some commercial

programs to prevent listing. E.CTR is a

compressed, piggyback exec file ver-

sion of a conventional program listed

on page 151 of reference 2. This file

writes a one line program at 63999 (the

highest program line permitted in

E.CAPI may also be used to transform integer into floating point programs. The procedure is as follows. After installing integer via a language or hardware card, load the integer program to be captured. Then exec E.CAPI which puts the program into the exec file, TEXT.I, and saves it on the disk. Next, convert to floating point and

ble, control D between the quote

marks.

execute TEXT.I, which loads the captured program into memory. At this point, the original integer program is now a floating point program which may be saved in the conventional manner. It is important to remember that there are differences between the commands used by integer and floating point programs. The new, floating point version may not work. If so, it will require appropriate corrections. However, E.CAPI saves the time of reentering and existing integer program. This procedure works because the floating point language does not check for syntax errors until the program is run. (Fortunate for this approach - unfortunate for programmers!) The integer language checks for errors during listing, so it is not possible to use E.CAPA to transform floating point into integer programs.

Applications

Exec files can be a very powerful programming tool. I have a working disk containing E.MEM, E.GR1, E.GR2, E.CTR and E.BIN. Thus, I can examine memory, look at the contents of either graphics page, "see" hidden control

characters or find the address and needed and without disturbing the program I have in memory. The names used here are to remind me these are exec files — they could be saved under any other valid name.

I have a second disk containing an extensive library of exec file subroutines created by E.CAPA. These have titles indicating their function and line number range. Some examples are: TITLE CENTER 1000-1005; TIME DELAY 3000-3010; and INPUT 7000-7070. Thus, when writing programs. I auto-write any subroutines I need by executing the appropriate file. After finishing the program, I compress it by using the renumber routine. Of course, it is necessary to keep track of, 1. or use a common set of, variables for subroutines which are added to an existing program.

Exec files are both powerful and 2. dangerous since they mimic keyboard input. This is especially true of piggyback and other exec routines which 3 modify programs. Be careful when using a file the first time. Also be conscious of the changes caused by executing a file. If 176 is input to E.PTR

(Listing 5) to find the end of the prolength of any binary file whenever gram in memory, the answer will be incorrect since E.PTR adds three new lines during its execution. In contrast, E.MEM (Listing 4) which does not define any new variables, nor add any program lines, will show the correct

> There are numerous other possible exec file utilities which could be written. An obvious example is the codepokes program on page 77 of reference 2 which converts machine-language routines into a series of basic poke commands.

References

- N. D. Greene, Textfile Write Edit Read Program (T.W.E.R.P.), MICRO, No. 75, September 1983, p. 27.
- Apple II The DOS Manual, Apple Computer, Inc., Cupertino, CA 1981.
- N. D. Greene, Applesoft Memory Map Display, MICRO, No. 43, December 1981, p. 96.



Expanding the Commodore 1541 **Disk Drive**

by Michael G. Peltier Wichita, Kansas

A Muiti-Part Series on the 1541. Part 1: Expanding the User Commands

Introduction

This is the first part of a three part article discussing ways to expand the Commodore 1541 Disk Drive. Part 1 covers expanding the DOS by explaining the operation of the "U0" command and showing how to install the "UA" thru "UP" commands. Part 2 will explain how to expand the disk drive's RAM, including theory, construction, installation and testing of a 4K expansion RAM. The advantages and disadvantages of expanding the In RAM will be discussed. Part 3 will describe expanding the I/O operations to include parallel access to and from the Commodore 64, as well as adding a Centronix-type printer port to dump data for the disk directly to a parallel printer.

The User Command

The User Command ("UA" thru "UJ", or "U1" thru "U:") is provided to to install custom commands and to define parameters for these commands. The user command takes the form:

Biography

Mike is an electronics technician, technical writer, inventor of electronics devices, and designer of video games. After experiencing an electronic failure on his personal 1541 disk drive, he discovered that a lack of author of the 1541 Single Drive Floppy Disk Maintenance Manual, published by Peltier

"Ux" or "UX:" + CHR\$(parameter 1) + CHR\$(parameter 2) ...

In practice, the "x" is replaced by an index character which defines the location which is to be executed. Table 1 defines the valid index characters and their associated execution addresses in the 1541 memory.

Table 1

ndex Character	Address Executed
A	\$CD5F
В	\$CD97
С	\$Ø5ØØ
D	\$Ø5Ø3
E	\$ø5ø6
F	\$Ø5Ø 9
G	\$Ø5ØC
Н	\$Ø5ØF
I	\$FFØ1

\$EAAØ

allow a machine language programmer Location \$CD5F is the entry point for the read block routine. Location \$CD97 is the entry point for the write block routine. Locations \$0500 thru \$0511 constitute the user jump table. The jump table is provided by the user and typically contains a three byte IMP instruction for each index character. Each of these jump instructions, when executed, causes a jump to the entry point of a user-provided routine in order to process the custom command. Index character I causes a jump to \$FF01, but this has no practical value. Index character I causes a jump to \$EAA0 which is the entry point for the power-up reset routine.

Parameters such as track number, sector number, byte count and pointers may accompany the user command. Parameter values are one byte, so they must be between 0 and 255, inclusive. Consider the following example:

"UD: " + CHR\$(parameter 1) + CHR\$(parameter 2) + ...

Parameter 1 will be located at address \$0203, parameter 2 will be located at address \$0204, and so forth. Up to 38 parameters may be used. The parameters may be read by the userprovided routine at the locations listed in Table 2.

DADAM IOCATTON

Table 2

DADAM TOCATTON

PARAM	LOCATION	PARAM	LOCATION
1	\$ Ø2Ø3	2Ø	\$Ø216
2	\$Ø2Ø4	21	\$Ø217
3	\$Ø2Ø5	22	\$ Ø218
4	\$ø2 ø 6	23	\$Ø 219
5	\$Ø2Ø7	24	\$Ø21A
6	\$ Ø2Ø8	25	\$0 21B
7	\$Ø2Ø9	26	\$ Ø21C
8	\$Ø2ØA	27	\$0 21D
9	\$ Ø 2 Ø B	28	\$Ø 21E
10	\$Ø2ØC	29	\$Ø21F
11	\$Ø2ØD	30	\$Ø22Ø
12	\$Ø2ØE	31	\$0221
13	\$Ø2ØF	32	\$Ø222
14	\$0210	33	\$Ø223
15	\$Ø 211	34	\$Ø224
16	\$Ø 212	35	\$Ø225
17	\$Ø 213	36	\$ø226
18	\$0214	37	\$0227
19	\$0215	38	\$Ø228

serious documentation for this device. He is Industries, 1984.

Expanding the User Command

The user command may be expanded to include index characters A thru P. This gives the programmer 16 new commands to work with. Locations \$006B and \$006C, respectively, contain the low and high bytes of the starting location of the user address table. The user address table differs from the user iump table discussed earlier in that the user address table has only two bytes per index character. These bytes are the low and high bytes of the locations to be executed. In the unexpanded mode, \$006B contains \$EA and \$006C contains \$FF. These addresses point to the user address table starting at \$FFEA. The user address table contains the following information:

Table 3

Contents	Index	Vector
\$5F	A	\$CD5F
\$CD		
\$97	В	\$CD97
\$CD		
\$ØØ	С	\$Ø5ØØ
\$Ø 5		
\$Ø3	D	\$Ø5Ø3
\$Ø5		
\$Ø6	E	\$Ø5Ø6
\$Ø5		
\$Ø9	F	\$Ø5Ø9
\$Ø5		
\$ØC	G	\$Ø5ØC
\$Ø5		
\$ØF	Н	\$Ø5ØF
\$Ø5		
\$Ø1	I	\$FFØ1
\$FF		
\$AØ	J	\$EAAØ
\$EA		
	\$5F \$CD \$97 \$CD \$ØØ \$Ø5 \$Ø5 \$Ø6 \$Ø5 \$Ø6 \$Ø5 \$Ø6 \$Ø5 \$Ø5 \$Ø5 \$Ø5 \$Ø5 \$Ø5 \$Ø5 \$Ø5	\$5F A \$CD \$97 B \$CD \$ØØ C \$Ø5 \$Ø3 D \$Ø5 \$Ø6 E \$Ø5 \$Ø6 E \$Ø5 \$Ø6 G \$Ø5 \$Ø6 H \$Ø5 \$Ø7 H \$Ø5 \$Ø1 I \$FF \$AØ J

Notice that locations \$FFEE thru \$FFF9 in the user address table contain vectors which point to the user jump table in locations \$0500 thru \$0511. Although only 10 index characters are shown in the table, DOS will support up to 16, giving a total table length of 32 bytes (two bytes per command). To expand the user command to include all 16 index character (A thru P), change the user address table pointer at \$006B (low byte) and \$006C (high byte) to point to a 32 byte USER table in RAM. Enter the table in the following format:

Table 4

Address	Contents	Index
p+Ø	\$5F	A
p+1	\$CD	
p+2	\$ 97	В
p+3	\$CD	
p+4	low byte vector	C
p+5	high byte vector	•
p+6	low byte vector	D
p+7	high byte vector	•
•	•	•
•	•	•
•	•	•
p+3Ø	low byte vector	P
p+31	high byte vector	•

(p = user address table base pointer contained in \$006B and \$006C)

Note that it is necessary to set p+1 thru p+3 to the values shown in order to preserve the read block (U1 or UA) and the write block (U2 or UB) commands. If, however, the read and write block commands are not needed, then the above locations may be used for other vectors. Each of the vectors in the above table point to entry points of the

user-provided routine. The new table in RAM may be created or altered by the user. As in the unexpanded mode, the expanded mode also allows the use of parameters 1 thru 38.

To return to the unexpanded mode, use the "U0" command. This command sets the user address table pointer back to \$FFEA, which restores the original user table.

Using all 16 expanded user commands may be difficult due to the lack of useable RAM for programming. Up to 1K of RAM may be used for programming (buffers 0 thru 3, \$0300-\$06FF). However, as these buffers are filled with programs, they are no longer available for data transfer, thus reducing the number of file which may be opened at any one time. This problem will be solved in Part 2 of this article by expanding the 1541 RAM to 6K. This will be accomplished with a plug-in 4K RAM module that you can build yourself.

"On Nov. 15, adopt a friend who smokes."

Larry Hagman

Help a friend get through the day without a cigarette. They might just quit forever. And that's important. Because good friends are hard to find. And even tougher to lose.



A Very Moving Message

Split Screen, Fine Scrolling and Interrupt Techniques Combined in a Useful Utility for the Commodore 64

Summary

Here's a program you can very quickly: type into your Commodore 64. It will add to your computer's usefulness and show off some of its good features at the same time. The program runs a 'marquee-type' message across the screen of the computer. This feature allows you to use the C64 as part of an 'electronic bulletin board' application, either alone or in combination with other programs. The message and its configuration can be custom-tailored to suit your needs. The program takes advantage of the computer's finescrolling capabilities to move the message smoothly and evenly across any part of the screen.

The Moving Message

Here's another application for home or club ... the computer as a moving message display device. This is a flashy way to leave a message for others in your family, or you can use it to announce schedules or special events in a club environment. You can even add it in to other programs and use the message to give instructions, advice in an adventure game and so on, while the other program is running. This little machine-language routine will run a continuous marquee-type message across either the top or the bottom of the screen, or any other line that you

by Ian Adam Vancouver, British Columbia, Canada

choose. The message that it runs can be up to 255 characters long, enough to cover most typical applications. The message or the way it is displayed can be changed easily to suit your needs. About the only limitation is your imagination!

Using the program is very simple. All you need to do is type in the BASIC program for your computer, being sure to SAVE a copy, then run it. You will then be asked to specify where on the screen you want the message to appear and to enter it according to the instructions. That's all there is to it! Your message will appear as if by magic, sliding continuously across the screen. Once it is working, it will continue to do so until you stop it.

The program shows off a number of very interesting features of your computer which we'll look at in a moment. In particular, note that it runs on an 'interrupt' basis. This means that it will continue to run when the program that loaded it is finished. You can even load in and run a different program and the message will still be displayed in most cases. The simplest way to stop the message is to press the RUN/STOP and RESTORE keys simultaneously. It can be restarted by typing SYS 49152.

For those who are interested in the details, the BASIC program loads in a machine-language program that does the serious work. This program is located in the spare RAM beginning at 49152. A commented assembly listing of the machine code is included in case you want to see how it works, but you'll still need the BASIC program to load in your message.

Additional Instructions

Once it is debugged and working, here are some additional instructions you may find useful in operating the display.

- 1. Changing text color: simply POKE location 49248 with a number from 0 to 15 to change the color of the text in the banner.
- 2. Background color: the color of the screen background and display background cannot be changed in the usual way (with a POKE to location 53281). The new locations to POKE are 49267 for the screen color and 49266 for the background of the message.
- 3. Changing the message: type GOSUB 9750 and follow the prompts to enter a new message. (alternatively, you can

0	1Ø PRINT CHR\$(147)
~	20 PRINT " MOVING MESSAGE 64:
	30 PRINT "
	40 PRINT " BY IAN ADAM (DOWN)
0	50 PRINT "THIS PROGRAM SCROLLS A BANNER MESSAGE ACROSS THE SCREEN USING
	80 GOSUB 9500
	9Ø PRINT "{DOWN}
0	*PRESS RETURN TO LOAD MESSAGE.{UP}":INPUT A\$
	100 GOSUB 9600:GOSUB 9750
	110 PRINT "{DOWN4}ADJUSTMENTS:{DOWN}
0	120 PRINT "POKE 49248, TEXT COLOUR
	130 PRINT "POKE 49266, COLOUR OF BANNER 140 PRINT "POKE 49267, COLOUR OF MAIN SCREEN
	150 PRINT "SYS 49152 ENABLE MESSAGE
0	160 PRINT "GOSUB 9600 CHANGE MESSAGE LOCATION
	170 PRINT "GOSUB 9750 NEW MESSAGE
	18Ø END
0	9480 REM READ AND POKE DATA INTO MEMORY
	9500 FOR I=49152 TO 49273
	9510 READ A:POKE I,A 9520 T=T+A:NEXT
0	9530 IF T-15669 THEN PRINT "CHECKSUM ERROR -
1 0	DOUBLE-CHECK DATA! ":STOP
	954Ø RETURN
0	958Ø REM WHICH LINE ?
	9600 PRINT "{DOWN}PICK ANY LINE FOR THE MESSAGE
	9610 PRINT "1 IS TOP LINE, 25 IS BOTTOM LINE
	9620 INPUT "WHICH LINE"; N%
0	963Ø IF N%<1 OR N%>25 THEN 961Ø
	964Ø X=4Ø*N%+768
	9650 Y=X AND 255 9660 POKE 49245,Y:POKE 49250,Y
0	9670 $X=(X-Y)/256$
	968Ø POKE 49246,X:POKE 49251,X+212
	969Ø X=42+8*N%
0	9700 POKE 49271,X:POKE 49270,X+8
	971Ø RETURN
	973Ø REM ENTER MESSAGE
0	975Ø A\$=CHR\$(164):PRINT CHR\$(147); 976Ø FOR I=1 TO 255:PRINT A\$;:NEXT
	977Ø PRINT CHR\$(215)
	978Ø PRINT "{DOWN}
0	TYPE MESSAGE AT TOP OF SCREEN, USING
~	979Ø PRINT "LOTS OF SPACE, MOVE CURSOR DOWN TO {\dagger{w}}
	, THEN PRESS RETURN
	9800 POKE 631,19:POKE 198,1
0	9810 INPUT A\$ 9850 A=49273:B=1023
	986Ø FOR I=1 TO 255:S=PEEK(B+I)
	9870 IF S=100 THEN S=32
0	988Ø POKE A+I,S:NEXT
	9890 POKE 53265,27:SYS 49152:RETURN
	9910 REM ENTER DATA CAREFULLY !!!
0	993Ø DATA 12Ø,169,127,141,13,22Ø,169,1,141,26,2Ø8,
	169,23,141,20,3,169,192
	9940 DATA 141,21,3,88,96,173,25,208,141,25,208,162,0, 189,114,192,141,33
0	9950 DATA 208,189,116,192,141,22,208,189,118,192,141,
	18,208,138,73,1,141,30
	996Ø DATA 192,240,3,76,188,254,165,162,41,7,73,7,141,
0	116,192,201,7,208
_	997Ø DATA 38,174,12Ø,192,232,236,121,192,2Ø8,2,162,Ø,
	142,120,192,160,216,189
0	9980 DATA 122,192,153,232,6,169,15,153,232,218,232, 236,121,192,208,2,162,0
	9990 DATA 200,208,234,76,49,234,0,6,7,200,8,241,0,
	255
<u></u>	

enter the message by poking the screen codes into memory beginning at location 492741.

4. Changing the location on the screen: type GOSUB 9600 and follow the prompts to change the location on the screen. Note that if you have not selected the top of the screen for the message, then scrolling the screen will create a bit of a mess.

5. Spacing: the moving message will have greater impact if you spread it out a bit, adding lots of spaces or other characters such as asterisks. The full length of the message is normally displayed, taking 34 seconds to scroll across the screen of the C64. The message will then repeat indefinitely. It is normally best to operate the program that way, but if you have a short, urgent message that you want to repeat more often, you can POKE its length into location 49273. If you want to display a very long message, your program can simply divide the message into segments of 255 characters and change the segment occasionally.

Technical Features

This program demonstrates a number of the special features of your Commodore 64. If you're not 'into' machine language or details of the computer you can just skip over this section, since you don't need to know all the details in order to run the program. However, if you want to know a bit of what makes the machine tick, then read on.

The BASIC program you see is a 'loader' for a machine language routine that, in effect, becomes part of the computer's operating system. This approach shows off at least three of your computer's special features:

- 1. modifying the interrupt routine.
- 2. split screen techniques.
- 3. fine scrolling and other control registers on the video chip.

Here's a little more on how each of these works:

Interrupt routine

Sixty times each second, the computer 'interrupts' what it's doing to carry out some housekeeping chores - checking the keyboard, updating the clock, washing the dishes and so on. In order to do this, it jumps to a special routine in memory that contains the instructions. The computer needs to know where this 'interrupt routine' is

located, so it stores the address in a pointer, held in locations \$0314 and 0315 (decimal numbers 788 and 789).

The address normally held in that pointer is \$EA31 on Commodore 64. What we will do is change the pointer so that it directs the computer to our routine instead. Our routine will take care of moving the message one step across the screen; when it's finished, we return control to the normal routine, to take care of the usual housekeeping tasks.

Split screen technique

The picture on your TV or monitor is formed by a series of horizontal scan lines projected sequentially from top to bottom of the screen. The video chip in the computer keeps track of where the raster scan line is on the screen and will alert you at any point on the screen you request. This is handy for switching various displays in and out on different parts of the screen, resulting in a display that could be, for example, part graphics and part text. This is known as a split screen.

In this case, we will ask the chip to generate an interrupt twice on each screen: first, when the scan line gets to the beginning of our message, we will select the color of the screen to suit. We will also adjust the horizontal position and narrow the screen to hide the letters coming on. Then, when the video chip indicates it has reached the bottom of our message line, we will set the screen color, position and width back to normal. We will also take this opportunity to slip the display a little to the left, while it is out of sight [so that it won't flicker].

Fine scrolling

It is fairly easy to write a program like this to jump the message across the screen one letter at a time - in fact, you can even do it using BASIC. However, this program uses the capability of the C64 to move the display across the screen one pixel at a time. This results in a very smooth scrolling effect, as there are eight pixels to each character. You have no doubt seen this feature used before, although you may not have realized it. It is often used by games to create an illusion of horizontal motion on part of the screen, for example to move traffic from side to side in frog games, or to scroll helicopter battles sideways.

	•	MESSAGE PROGR	- •	0
	; FOR USE (ON THE COMMODO	JRE 64 ———	
	; BY IAN AI :	DAM		_
	; MOVING M	2 TO ENABLE TH ESSAGE DISPLAY		0
ØØA2 Ø314	IRQPTR I	EQU \$A2 EQU \$Ø314		0
Ø328 DØ12 DØ16	VICRST 1	EQU \$Ø328 EQU \$DØ12 EQU \$DØ16		0
DØ19 DØ1A	VICIRQ I	EQU \$DØ19 EQU \$DØ1A		
DØ21 DCØD D728	CIAICR 1	EQU \$DØ21 EQU \$DCØD EQU \$D728		0
EA31 FEBC	OLDIRQ	EQU \$EA31 EQU \$FEBC		0
CØØØ		org \$cøøø	; ROUTINE RESIDES IN UPPER RAM	
CØØØ 78 CØØ1 A9 7F		SEI LDA #\$7F	; BLOCK OUT INTERRUPTS	0
CØØ3 8D ØD DC CØØ6 A9 Ø1	5	STA CIAICR LDA #\$Ø1	; TURN OFF HARDWARE TIMER	0
CØØ8 8D 1A DØ CØØB A9 17	Š	STA VICIMR LDA #MOVER	; ENABLE RASTER INTERRUPTS	
CØØD 8D 14 Ø3 CØ1Ø A9 CØ]	STA IRQPTR LDA /MOVER	; RESET IRQ POINTER TO START ; OF NEW PROGRAM	0
CØ12 8D 15 Ø3 CØ15 58 CØ16 6Ø	(STA IRQPTR+1 CLI RTS	; RE-ENABLE INTERRUPTS ; RETURN TO BASIC	
	;			0
CØ17 AD 19 DØ CØ1A 8D 19 DØ CØ1D A2 ØØ	5	LDA VICIRQ STA VICIRQ LDX #\$ ØØ	; ACK INTERRUPT TO ; VIDEO CHIP ; POINTER TO BYTE +1	0
CØ1F BD 72 CØ CØ22 8D 21 DØ]	LDA COLOR,X STA VICBGC	; GET BACKGROUND COLOR ; AND STORE IT	
CØ25 BD 74 CØ CØ28 8D 16 DØ]	LDA CONFG,X STA VICCTL	; GET SCREEN CONFIG. : AND STORE IT	0
CØ2B BD 76 CØ CØ2E 8D 12 DØ]	LDA RASTR,X	; GET NEXT RASTER VALUE ; AND STORE IT	
CØ31 8A CØ32 49 Ø1	`. 1	TXA EOR #\$Ø1	; LOOK AT POINTER ; FLIP IT OVER	0
CØ34 8D 1E CØ CØ37 FØ Ø3	I	BEQ SLIDE	; AND STORE FOR NEXT TIME	0
	;		; IF MESSAGE NO ON, GET OUT.	
	; RELOCATE ; NOT JERK	IT SO THAT TH	BEING SCANNED, HE DISPLAY IS	0
CØ3C A5 A2 CØ3E 29 Ø7	1	AND #\$Ø7	; SET SYSTEM CLOCK BYTE ; CONVERT INTO DECREASING SCAL	0
CØ4Ø 49 Ø7 CØ42 8D 74 CØ	5	STA CONFG	; FOR A SMOOTH SCROLL ; SAVE FOR NEXT TIME	7
CØ45 C9 Ø7 CØ47 DØ 26			; IF 7, THEN SCROLL MESSAGE LE ; IF NOT 7, BYPASS THESCROLL	0
CØ49 AE 78 CØ CØ4C E8	SCROLL 1	INX	; WHERE IN THE MESSAGE? ; MOVE OVER ONE SPACE	0
CØ4D EC 79 CØ CØ5Ø DØ Ø2	I	BNE CONTIN	; ARE WE AT THE END ? ; NO, SO CONTINUE	V
CØ52 A2 ØØ CØ54 8E 78 CØ	CONTIN S	LDX #\$ØØ STX POSITN	; YES, SO START OVER ; SAVE FOR NEXT TIME ; Y REGISTER IS SCREEN INDEX	0
	;	ப மிப்ப	, I REGIOTER TO DORDEN INDEA	

0	CØ59 BD 7A CØ	GETCHR LDA MESAG,X ; GET A LETTER OF MESSAGE
	CØ5C 99 28 Ø3	
	CØ5F A9 ØF	LDA #\$ØF
_	CØ61 99 28 D7	,.
0	.,	;
		; SCRN AND SCOL ARE OFFSET VALUES FOR
		; START OF SCREEN DISPLAY AND COLOR
0		; MEMORY. THEY ARE CHANGE BY THE BASIC
•		; LOADER IF NECESSARY.
		;
	CØ64 E8	INX
0	CØ65 EC 79 CØ	CPX LENGTH ; END OF MESSAGE ?
	CØ68 DØ Ø2	BNE NEXT ; NO
	CØ6A A2 ØØ	LDX #\$ØØ ; YES, CONTINUE FROM START
0		;
	cø6c c8	NEXT INY ; NEXT SCREEN POSITION
	cø6d dø ea	BNE GETCHR ; MORE TO DO?
	CØ6F 4C 31 EA	EXIT JMP OLDIRQ ; OVER AND OUT
0		;
		; FINISH CHORES BY JUMPING BACK TO
		; THE STANDARD 64 IRQ ROUTINE
0		;
	CØ72 ØØ ØØ	COLOR DBY Ø
		CONFG DBY Ø
	CØ76 ØØ ØØ	RASTR DBY Ø
0		POSITN BYT Ø
	CØ79 ØØ	LENGTH BYT Ø
	CØ7A ØØ	MESAG BYT Ø ; START OF MESSAGE AREA
	CØ7B	END

One Final Message

Try this program in your machine - I'm sure you'll find it useful and it gives a few more ways to put your powerful home computer to practical use. I'll award a prize for the most imaginative application I hear of. Meanwhile, may the power be with you!

Biography

Ian Adam is a Transportation Engineer with the City of Vancouver, British Columbia. Home to mountains, killer whales, and lots of rain, British Columbia is known locally as 'Lotus Land'. After dealing with the routines of traffic and transit through the city all day, Ian finds routing information around the inside of a computer an ideal way to relax. While also programming on the VIC 20, Apple II and IBM PC, his preference is for the Commodore 64. Unfortunately, he must share this with his wife Linda and his two sons Paul and Doug.

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Every Apple user needs this book, for it provides the most detailed description available of Apple II firmware and hardware.

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• The address in hexadecimal (useful for assembly programming) \$FC!	8
• The address in signed decimal (useful for BASIC programming) (-93	6)
• The common name of the address or routine	
• Information on the use and type of routine\SE`	Ū
A description of the routine CLEAR SCROLL WINDOW TO BLANK	S.
SET CURSOR TO TOP LEFT CORNE	R
Related register information)

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feedback

Dear Harvey,

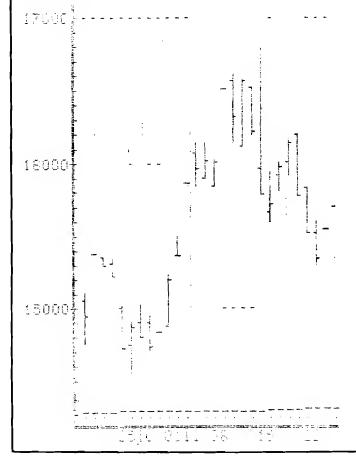
In response to your letter in MICRO, June 1984, I offer the following.

First, with the exception of addition of a second time series and third label, the Quickplot{tm} routine which is part of Quicktrieve supplied by Commodity Systems Inc., 200 W. Palmetto Park Road, Boca Raton, FL 33432 [305/392-8663], does what you want with either daily commodity futures or stock or stock options data which they sell. Unfortunately, the program is supplied only in compiled form and is intimately tied to acquisition through their system on a regular basis.

I expect to eventually write my own program of that nature, if the demand develops. In the meantime, I do my plots on an MX-100 with substantially higher resolution than Apple Hi-Res graphics. A sample is enclosed. I have several years of use of Apple in commodity trading, If this interests you, or any MICRO reader, feel free to write.

Jere Murray Seldovia Paint Software Box 237 Seldovia, AK 99663

Portion of Sample Commodity Chart (The whole chart is 15 by 25)



Dear Mr. Tripp:

I'm delighted to find the lead article on the Dvorak keyboard in your July 1984 issue. There is, indeed, a growing awareness of the inherent awkwardness of the QWERTY keyboard arrangement.

After 20 years of QWERTY in my daily work, I switched to Dvorak in 1965, cold turkey. I was never sorry, not even one day, though for the first six weeks or so my usual 80 wpm began again from 15 to 20 wpm and slowly became 35, then 60, and a year later 100 plus. I cannot imagine going back, although my two daughters, trained from high school on Dvorak, had to switch to OWERTY in order to obtain employment in their chosen line of work. Those were premicrocomputer years. Now, there's no problem getting the new ANSI Standard Keyboard (ASK, which is Dvorak with the numeral row left in the old ascending arrangement on virtually any computer. The article neglected to mention the 1983 action of the American National Standards Institute in adopting Dvorak's ASK variant officially. Many persons might take Dvorak more seriously once they realize that it has official blessing.

It is not even mentioned by Radio shack, more's the pity!, that SCRIPSIT has the ASK keyboard arrangement resident. For those who use SCRIPSIT 2.0, a simple patch on a working master is all that's required to convert their keyboard {from TRSDOS Ready, PATCH SCRIPSIT ADDFA FD7 CD8}. Thus, Radio Shack is among the very first computer manufacturers, along with IBM and Apple, to recognize the value of the new keyboard, in spite of their apparent modesty. Apple IIc has a hardware switch for using either keyboard at will.

The DSK is everything it's touted to be, and more. There are a growing number of converts to ASK. But since DSK and ASK are in the public domain, why try to persuade anyone that there's an advantage in switching away from QWERTY, since there's no money to be made? It's a rare person who believes that a gift can come sans strings attached. I can use QWERTY at 35 wpm, DSK and ASK as 100. It is not easy to learn to use more than one of them, since there is a tendency to overlap, just as a foreign language user slips an occasional native word into his conversation. But it does give me a basis for objective evaluation of all three: I pronounce Dvorak superlative in all respects. ASK is a beautiful compromise.

Sincerely,

Waldo T. Boyd P.O. Box 86 Geyserville, CA 95441

-interface clinic

A Mystery!

At first glance, the Commodore 64 seems to be ideally suited for timing and counting measurements. That is, it has two Time of Day clocks and two independent counters for our use, and all of them produce interrupts. However, I

developed a number of frustrations while trying to use these features to calibrate a Voltage-to-Frequency Converter (VFC). Let's get some background on VDCs and their calibration; then I'll explain my frustrations. If any one of you can solve the problems more neatly than I did, the podium is yours! Just write me c/o MICRO and tell me

your solution.

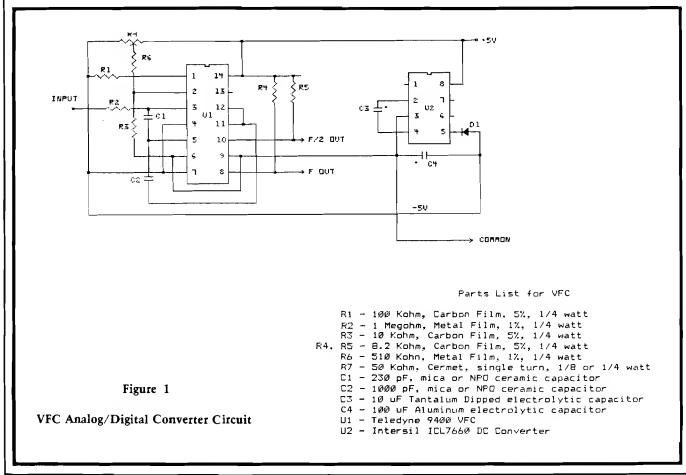
Figure 1 shows the circuit of the VFC as implemented on the User Port adapter reported several columns back [MICRO 70:54, March 1984]. (For those who haven't seen that report, skip forward to the section on the User Port Adapter.) U1 is the VFC, which requires + and - 5V power supplies. U2 is a low-power inverter which runs from +5V and produces about -4.5 V. Only a few connections are made to the User Port for this circuit: +5V, Common, PB7 and CNT2. Depending on the operating mode, you will count pulses or the time between two pulses, depending on the calibration mode.

by Raiph Tenny Richardson, Texas

VFCs Explained!

Most modern VFCs work on a charge balancing principle which minimizes error producing influences. Charge balancing is done by charging a capacitor from an external source for a while, then quickly discharging it from an internal calibrated source. The internal discharge rate is constant, and the external charging rate is proportional to the external voltage. [The length of time for external charging is set by the external voltage.] With a large external voltage, the capacitor is charged rapidly, so the switch-over to discharge comes quickly. The switch signal [see Figure 2a] is brought out for our use, and its frequency is directly proportional to the external voltage. The Teledyne 9400 VFC used in this experiment also furnishes a square wave at half the output frequency (Figure 2b). We will use both in the experiment to be discussed.

A number of very good VFCs are available at quite low prices. Typical specifications are: 0.01% linearity to 10 KHz and 0.0025% gain stability with temperature. At full scale (10 V input = 10 KHz), the measurement resolution is better than 13 bits! A 13-bit A/D converter is several times more expensive, depending on how fast the conversion is. Even at 1 V input (1 KHz), the resolution is almost 10 bits. The tradeoff is that full-resolution measurements require one second to complete. Also, the measurements



need two bytes of memory for storage of each test result. If you don't need high resolution, use one-tenth second measurement periods to save time and memory space.

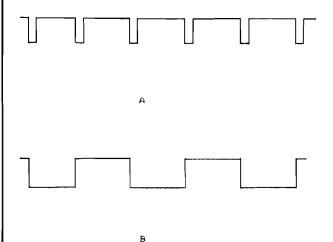


Figure 2 Output Waveforms from the VFC

Calibration Woes

Two calibration points are needed on this particular VFC. First, I need to set the frequency output for 10 KHz with 10 V input, and then minimize the zero offset. Zero offset affects the accuracy at very low input voltage, so the frequency is adjusted to 20 Hz at 20 mV input. This calibration must use a period measurement to get adequate resolution.

My first frustration came when trying to calibrate the full-scale response of this VFC. I have been using HESMON64 for all of my hardware and interfacing experiments, with mostly good results. The first idea I had for full-scale calibration was to operate the TOD clock on U2 {NMI interrupt} with one second interrupts. None of the several reference books I have mentions how to set the TOD interrupts, except in a general way. Setting the TOD clock is supposed to be done beginning with the Hours/AM-PM register and finishing with the Tenth Second register. The clock starts running when the Tenth Second register is loaded, so that the starting time can be precisely controlled. Setting the Alarm is supposed to be the same, except that BIT7 of each register is supposed to be set also.

The bit map of the TOD registers looks like this:

ADDR	REG	BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BITØ
BIDDU	SEC/10	ø	Ø	ø	ø	Т8	ጥሬ	TЭ	т1
	, .								
DD Ø 9	SEC	Ø	2114	SH2	SuT	PTQ	214	ملاد	OLI
DDØA	MIN	Ø	MH4	MH2	MH1	ML8	ML4	ML2	ML1
DDØB	HRS	PM	Ø	Ø	HH1	HL8	HL4	HL2	HL1

Note that the registers are arranged in ascending order, with time kept in BCD. The first hurdle is that HESMON reads and writes eight bytes in its memory modifying mode, reading from low to high. So, if you manage to get the clock running with HESMON, reading the time reads the Hours register last, stopping the clock. Similarly, writing via memory modification writes the Tenth Second register first instead of last, failing to start the clock. The clock can be started using this brief program:

```
A2 Ø3
                     LDX #$Ø3
                                    ; MOVE FOUR NUMBERS
BD ØC CØ
                                    ; GET DATA
                     LDA BUFR, X
9D Ø8 DD
                     STA $DDØ8,X
                                    ; AND WRITE IT
CA
                     DEX
                                    ; IN REVERSE ORDER
1Ø F7
                     BPL GET
                                    : LOOP
ØØ
                     BRK
                                    ; HESMON STOP
ØA ØF 1E
           BUFR
                     BYT HRS, MIN, SEC, STEN
           ; SAMPLE SETTINGS
           HRS
                     EQU 10
           MIN
                     EQU 15
           SEC
                     EQU 3Ø
           STEN
                     EQU Ø6
```

The clock starts easily with that program segment. Using several similar segments to set the ALARM function apparently failed each time. At least, I couldn't find an interrupt service routine which demonstrated interrupt operation!

My intent had been to use one-second interrupts from the TOD clock to calibrate the VFC. In this operation, the VFC pulse output is connected to CNT2 so that Timer B accumulates pulses from the VFC. Eventually, I devised this program to generate one second interrupts for that purpose:

CE ØØ 2Ø	DE	C \$2000	;	REP COUNTER
1Ø Ø9	BF	L KI	;	RESET INTERRUPT
A9 ØØ	LI	A #ØØ	;	STOP TIMERS
8D ØF DD	ST	A \$DDØF	;	TIMER B
8D ØE DD	SI	A \$DDØE	;	TIMER A
ØØ	BF	lK	;	RETURN TO HESMON
AD ØD DD	KI LI	A \$DDØD	;	RESET INTERRUPT
40	RI	'I	;	END INTERRUPT SERVICE
A9 D5	L	A #\$D5	;	SET TIMER A
8D Ø4 DD	SI	'A \$DDØ4	;	FOR Ø.1 SECONDS
A9 27	LD	A #\$27		
8D Ø5 DD	SI	'A \$DDØ5		
A9 Ø9	LI	A #\$Ø9	;	NEED 10 TIMER
8D ØØ 2Ø	SI	`A \$2000		
A9 FF	LI	A #\$FF	;	FULL COUNT IN TIMER B
8D Ø6 DD	SI	'A \$DDØ6		
8D Ø7 DD		'A \$DDØ7		
A9 Ø1		A #\$Ø1	;	SET NMI* VECTOR
8D 18 Ø3	SI	'A \$Ø318		
A9 2Ø	LD	A #\$2Ø		
8D 19 Ø3		'A \$Ø319		
A9 81		A #\$81	•	ENABLE TIMER A
8D ØD DD		'A \$DDØD	-	INTERRUPT
A9 Ø9	LE	A #\$Ø9		START TIMER B
8D ØF DD		A \$DDØF		IN ONE-SHOT MODE
A9 Ø1		A #\$Ø1		START TIMER A
8D ØE DD		'A \$DDØE		IN FREE-RUN MODE
4C 42 CØ	LP JM	IP LP	;	TIGHT LOOPS 1

When you RUN this program it should come back with the HESMON prompt almost immediately. Examine memory at \$DD06-DD07 (count in Timer B registers). The recorded count with +5V input will probably be about \$1388. There are two ways to calibrate this circuit. The first is to input a precise voltage [such as 10.0V] and adjust the value of R1 so the count is exactly \$2710 (10,000 decimal). The second is to put in a known voltage near full scale and record the count. From these values you can then compute a counts/volt and compute other voltages using this value. Here's an example:

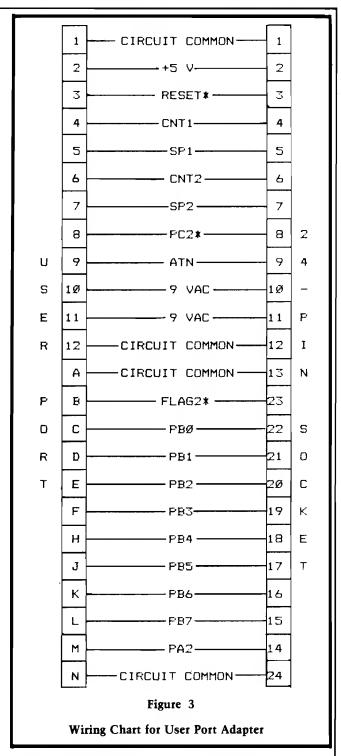
9.3V input yields \$244A or 9290 decimal. 9290/9.3 = 998.9 counts/volt.

If you get a count of 6320 decimal, the voltage is 6320/998.9 or 6.39V. The computations above were rounded off somewhat. It is unrealistic to keep all the digits your calculator gives you!. If you can calibrate this circuit to 0.5%, three digit resolution can exceed the accuracy available to you, depending on the input voltage.

Most analog devices have zero offset, and VFCs are no exception. The zero offset calibration experiment was a really major frustration. The calibration should be done with 20 mV input (output 20 Hz). By measuring the period of the VFC output with a timer counting the processor clock, significant resolution is possible. My original plan was to drive the FLAG input with the VFC output. FLAG is an edge-sensitive input, which means that once the line has been driven low it must go high before another interrupt can be generated. Also, the first interrupt must be cleared before another interrupt will be issued. (Clearing any interrupt of the 6526 CIA is accomplished by reading the Interrupt Control Register. To make a bitter story short, there apparently was severe interaction between any program using FLAG and the HESMON cartridge. The program below reads the half-period of the F/2 output. it waits until F/2 goes high, then low, and starts the counter. When F/2 goes high again, the counter is stopped. Connect the F/2 output to BIT6 of the User Port. Enter this program and run it repeatedly with a .02 V input to the VFC. Check the Timer B count after each run and adjust R7 until you get 51020 counts (\$C74C). Note: since the timer starts at \$FFFF and counts down, \$FFFF - \$C74C = 38B3. That is, the counter will show \$38B3 when the adjustment is correct.

78		SEI	;	DISABLE IRQ*
A2 ØF		LDX #\$ØF	;	COUNTER START
AØ ØØ		LDY #\$ØØ	;	COUNTER STOP
A9 FF		LDA #\$FF	;	SET COUNTER B FOR
8D Ø6 DD		STA \$DDØ	6;	MAXIMUM COUNT
8D Ø7 DD		STA \$DDØ	7	
2C Ø1 DD	IN1	BIT \$DDØ	1 ;	TEST FOR F/2 LOW
5Ø FB		BVC IN1	;	LOOP IF LOW
2C Ø1 DD	IN2	BIT \$DDØ	1 ;	TEST FOR HIGH
7Ø FB		BVS IN2	;	LOOP WHILE HIGH
8E ØF DD		STX \$DDØ	F ;	START COUNTER
2C Ø1 DD	IN3	BIT \$DDØ	1 ;	TEST FOR LOW
5Ø FB		BVC IN3	;	WAIT FOR LOW TO STOP
8C ØF DD		STY \$DDØ	F;	THEN TURN OFF COUNTER
ØØ		BRK	;	BACK TO HESMONS1

It was particularly irritating to have to resort to software loops as the *only* available way to make this calibration measurement! Remember: If you can make Commodore



user interrupts work well with HESMON or another debugger, tell us how!

You should be aware of some constraints on using this type of program for calibration against the processor clock. I tested that program with 5 V input to the VFC [about 5 KHz output]. Without the SEI instruction, internal interrupts would scramble about one sample in four. Even with the SEI, one in seven samples were stretched; I have no explanation. At the real calibration point, (20 Hz output), the signal was somewhat variable. Pulse jitter due to noise pickup was visible on an oscilloscope, but not to the extent shown in the data. The final calibration was done using an average of ten samples. The observed jitter in the data was ±2%.

User Port Adapter

Anytime you interface to a computer, it is much easier if you have a special work area for your experiments. The User Port is on the left rear of the Commodore 64, with a place to plug on an edge-eard connector. I developed a simple adapter which extends the User Port around near the front of the computer. Figure 3 shows the circuitry between the User Port and the extender cable. This adapter is simply a short piece of experimenter perf-board with a dual-readout 12 position connector soldered to it. The connector fits the User Port, and a 24 pin IC socket is mounted on the perf-board. A flat cable with 24 pin headers on each end carries the User Port connections to the front of the C-64. This end of the flat cable plugs into any of several breadboards and permanent boards which are experimental circuits or permanent interfaces.

Future Projects

For those who might be following the design discussion of networking my three computers, I'm still planning to report on the bus loading of the interface detailed in the previous column, and discuss a full eight-bit wide I/O port to replace the four-bit ports shown last month. The interface project has been temporarily slowed to meet other deadlines, and to order some interface breadboard cards to build the interface on. When the interface project gets under way again (probably by next column), at least two such breadboard cards will be discussed and the parts layout shown. In addition, the support software will be outlined.

Updates & Microbes

BASIC Hex Loader, Miero #73, page 65:

Line 9 in listing 2 had a '-' inserted by the typesetter. It should read:

9 MS> ME THEN PRINT "XX";: I=6:J=11

The Hex Loader was written to work with any Microsoft-like BASIC. Since the Atari's BASIC is significantly different, particularly in the area of string manipulation, a special version is required. Here is the Hex Loader modified for the Atari.

1Ø DIM X\$(4),HX\$(5Ø)

11 READ X\$:Z=LEN(X\$):GOSUB 17:MS=X:Z=2

12 READ HX\$:J=1

13 X=HX\$(J,J+1)

14 IF X\$=XX THEN END

15 IF X\$=YY THEN GOTO 12

16 GOSUB 17:POKE MS, X:MS=MS+1:J=J+2:GOTO 13

17 X=Ø:FOR I=1 TO Z:Y=ASC(X\$(I,I)):

IF Y> 57 THEN Y=Y-7

18 Y=Y-48:X=X*16+Y:NEXT I:RETURN

Sample DATA Statements

100 DATA 600

Starting Address

101 DATA A57A8D70YY Hex Data

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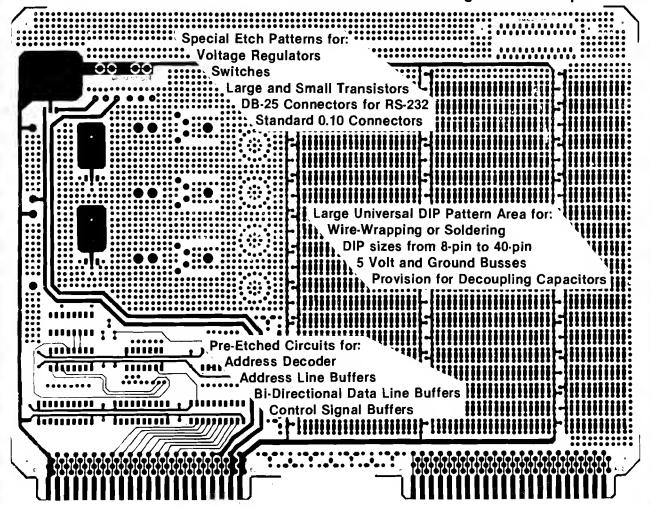
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Quick Cipher Routine

Protecting Your Information

by Art Matheny Lutz, Florida

Summary

In less than three seconds this 6502 machine language subroutine can encode 24 kilobytes into a cipher that is difficult to crack. The same routine decodes the data just as quickly.

Before storing a program or data on a public mass storage device or transmitting it over a public communications channel, it may be wise to encipher it. This short 6502 machine language subroutine quickly encodes a specified range of memory. The same subroutine decodes the data to recover the original memory contents. The routine takes less than three seconds (with a 1 MHz clock) to encode or decode 24 kilobytes. This is short compared to the time it usually takes to store or transmit the same amount of data.

The contents of the memory range could be a BASIC program, machine code, data tables, or a combination of all of these. it does not matter since every byte in the specified range undergoes transformation. Cryptographers call the original memory contents the plaintext, and they call the transformed data the ciphertext. The goal is to design a code such that if any codebreaker gets hold of the ciphertext, he would have a hard time recovering the plaintext.

The simplest scheme I have seen used for encryption of computer memory is as follows: One picks any number between 1 and 255 to use as a key. The ciphertext is produced by performing an exclusive-or (EOR) of this byte with every byte of the plaintext. To recover the plaintext, EOR the same key with every byte of the ciphertext. The trick is that two EOR instructions with the same byte

How You Can Keep Your Information Private — Even While Using Public Communications Channels and Databases

	;*****				
	;CIPHER ;*****				
	;				
	;QUICK CIPHE ;BY ART MATE				
	; TAMPA, I				
	;				
	; ENCODES OR ; A RANGE OF				
	; H HANGE OF	rieron i			
	; THE FOLLOW!; CAN BE LOCA; CONVENIENT	ATED AT AN	Y	-	
ØØFB	; PTR EC	QU \$ FB	;Z-PAGE	POINTER	
	; ;			_	
	;CHOOSE CON				
	;THE FOLLOW:				
	; COMMODORE 6				
	;			-	
Ø33C	; OF	RG \$330			
	; :			_	
	;JUMP TABLE				
	;			-	
Ø33C 4C 4A Ø3	JN	IP CIPHER			
Ø33F 4C 7Ø Ø3	JN	OP RIND			
	;				

		;—————————————————————————————————————
_		; ANGULENIA
•	Ø342 12 Ø343 34	SEED BYT \$12 ; POKE ANY 4-BYTE BYT \$34 ; SEED HERE.
0	Ø344 56 Ø345 78 Ø346 ØØ Ø8	BYT \$56 ;USE SAME SEED AT BYT \$78 ;DECODING TIME FIRST BYT Ø,8 ;STARTING ADDR
•	Ø348 FF 67	LAST BYT \$FF,\$67 ;FINAL ADDR;
		;CIPHER
0		; ;; ;COPY STARTING ADDR TO Z-PAGE
•	Ø34A AD 46 Ø3 Ø34D 85 FB	; CIPHER LDA FIRST STA PTR
0	Ø34F AD 47 Ø3 Ø352 85 FC	LDA FIRST+1 STA PTR+1
•		; ;EOR MEMORY BYTE WITH RANDOM BYTE
•	Ø354 AØ ØØ Ø356 2Ø 7Ø Ø3 Ø359 51 FB	EOR (PTR),Y
0	Ø35B 91 FB	STA (PTR),Y ; ;INCREMENT MEMORY POINTER
	Ø35D E6 FB	; INC PTR
0	Ø35F DØ Ø2 Ø361 E6 FC	BNE CIP2 INC PTR+1
0		; ;LAST BYTE YET
8	Ø363 AD 48 Ø3 Ø366 C5 FB Ø368 AD 49 Ø3 Ø36B E5 FC Ø36D BØ E7 Ø36F 6Ø	CIP2 LDA LAST CMP PTR LDA LAST+1 SBC PTR+1 BCS CIP1 RTS
8	שט יוטקש	;
0		;RANDOM NUMBER GENERATOR ;RETURNS RANDOM BYTE IN THE .A REGISTER ;
8	Ø37Ø 18 Ø371 A2 Ø3 Ø373 BD 42 Ø3	; RND CLC LDX #3 LDA SEED,X
③	Ø376 CA Ø377 7D 42 Ø3 Ø37A 9D 42 Ø3 Ø37D CA	DEX RND1 ADC SEED,X STA SEED,X DEX
0	Ø37E 1Ø F7 Ø38Ø A2 Ø3 Ø382 FE 42 Ø3 Ø385 DØ Ø3	BPL RND1 LDX #3 RND2 INC SEED,X BNE RND3
0	Ø387 CA Ø388 1Ø F8 Ø38A 6Ø	DEX BPL RND2 RND3 RTS
0	Ø38B	END

Art Matheny was a physics teacher before he took up full-time programming. He is now employed at the University of South Florida as assistant in scientific computing for the College of Natural Sciences. At home he programs on his Apple II, Commodore 64 and VIC-20.

has no net effect. This simple code disguises the data alright, but it is nothing more than a simple substitution code, which can be cracked by age-old methods. The code-breaker can determine the substitution table without ever having figured out that the EOR instruction was used.

My scheme also uses the EOR instruction, but first a fast random number routine generates values to EOR with the data. The key in this case is a four-byte SEED value, which determines the pseudo-random sequence. Decoding is accomplished by calling the same routine with the SEED bytes reset to the key values. At the start of encoding, any four bytes can be poked into the SEED locations. Because these bytes are modified by the program, they must be reset to the same key values at the start of decoding. The FIRST and LAST addresses of the memory range must also be set. All of these arguments are located immediately following the jump table at the start of the program.

You do not have to use the particular random number generator given here. Any routine that generates onebyte values will work. The one included here was originally published in MICRO #51 (August 1982). In this application, its main virtues are that it is fast (about 69 cycles) compared to more sophisticated routines and that it generates an extremely long nonrepeating sequence. You may even choose to invent your own personal number generator. It does not have to be perfectly random, rather use some scheme that is so unlikely that the code-breaker would fail to guess it. Since many numbers need to be generated, speed is important. The main point is that the number sequence must be deterministic, while not appearing so. The sequence should be determined by some a seed value, which functions as the key of the code. The random number generator must return a random byte in the .A register.

All that is required to use the routine, once you have it loaded is to set the seed bytes and the starting and ending address of the information to be encoded. The addresses are stored in normal low/high byte order (at \$0346 and \$0348 in this version). Then, make a subroutine call to CIPHER through its jump table vector (JSR \$33C) from an assembly program or a SYS call from BASIC (SYS 828). Your encoded/decoded information will replace your original information.

0



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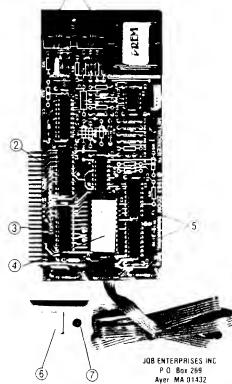
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